Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

SEPTEMBER, 1950

TECHNOLOGY DEPT.

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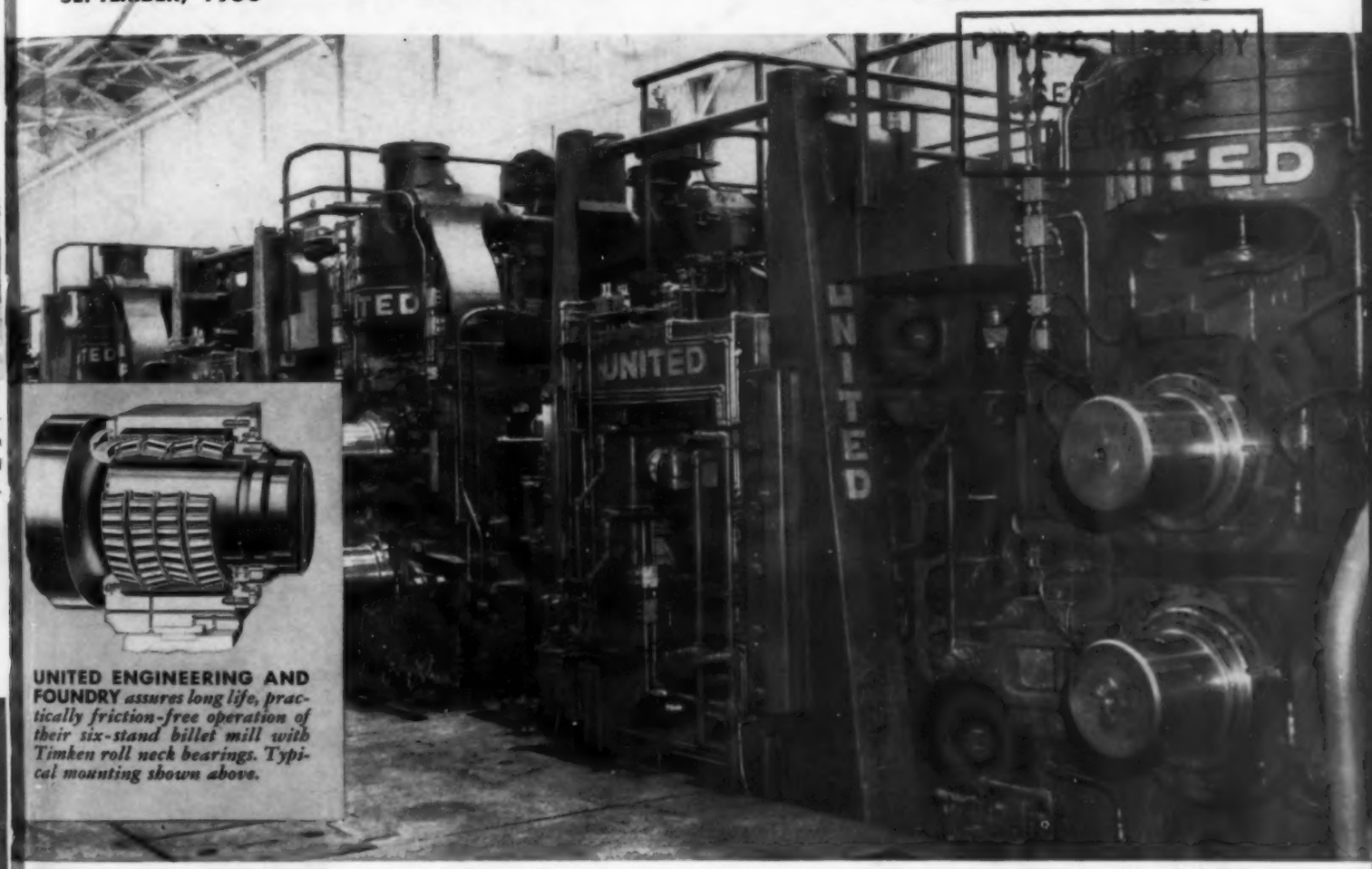


UNITED ENGINEERING AND FOUNDRY *assures long life, practically friction-free operation of their six-stand billet mill with Timken roll neck bearings. Typical mounting shown above.*

How to keep a roll neck from becoming a bottleneck

TO insure continuous production and long, trouble-free performance, the rolls of this United six-stand billet mill are mounted on Timken® roll neck bearings. By reducing friction, Timken bearings permit higher rolling speeds, eliminate roll neck wear.

Tonnage records indicate that the long life of Timken roll neck bearings keeps bearing cost per ton of steel rolled to a minimum. Thanks to balanced proportion design, Timken bearings give greater mill rigidity, permit larger diameter roll necks than ever before possible with tapered roller bearings. Roll neck strength is increased 50 to 60%. Load ratings are increased up to 40%.

Timken bearings permit the use of simple grease lubrication, eliminating complicated lubrication systems. Rolls can be changed more easily and faster. And since Timken bearings take both radial and thrust loads in any combination, no thrust bearings are necessary.

Write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

BE SURE TO VISIT OUR EXHIBIT
AT THE IRON & STEEL EXPOSITION
CLEVELAND, OHIO
BOOTHS 104, 105, 106 AND 107
SEPT. 26th THROUGH 29th

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION →✳←

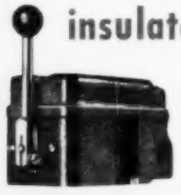
New Cam Operated MILL ACCESSORY MASTER

Has 3 separate insulated circuits

"FIVE BY FIVE"

Actual size of case 5½ x 5¼ x 5½

Also in 6 separate insulated circuits



Case measures 5½ x 5¼ x 8⅛

The new Cutler-Hammer Mill Accessory Master has been designed for the many steel mill applications where a cam operated type master switch of very small dimensions is required. This new small master is available with either 3 or 6 separate insulated circuits; cast iron case for surface mounting and in skeleton or sheet metal case for back-of-panel or bench-board flush mounting.

Five standard models are available for these usual types of magnetic controllers:

1. Single speed reversing without low voltage protection in the 3 circuit master.
2. Single speed reversing with low voltage protection in the 3 circuit master.
3. Two speed reversing without low voltage protection in the 3 circuit master.
4. Two speed non-reversing with low voltage protection in the 3 circuit master.
5. Single or two speed non-reversing or reversing with or without low voltage protection in the 6 circuit master.

In addition, both the 3 circuit and 6 circuit master may be had with "daisy-petal" twist-off cam elements adaptable to special circuit requirements . . . which enable you to stock a supply of these masters and tailor each to the requirements of each application.

The switch is provided with double break bridging contacts, molded arc-resistant arcing chambers. The switch has positive star wheel action with readily adjustable star wheel tension. Star wheel cam and roller, and switch cams and rollers, are case hardened. The cam shaft is mounted on self-aligning ball bearings. Handle can also be furnished as self-centering from either or both directions. The clamp-on type handle is readily adjustable to any angular position. The cast iron case of the surface type enclosure has conduit openings in both sides and one in the bottom. The switch is easy to wire, with solderless type lugs; each terminal is arranged for two wires. Rugged construction assures low maintenance. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

where can YOU use

this new mill accessory master?

HERE ARE BUT A FEW OF MANY PRESENT USES:

Blowers	Lifts	Pickling Tanks
Conveyors	Saws	
Electric Heaters	Machine Tools	Sizing Mills
Kick-offs	Mandrel	Solenoid
Levelers	Extractors	Valves

A pair of pliers does the trick!

When You Tailor This Master To The Job

When there are special circuit requirements to be met, both the 3 circuit and 6 circuit masters are available with "daisy-petal" twist-off cam elements which can be "tailored" to the needs of the specific job. Petals can be twisted off with a pair of pliers to form any cam arrangement.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 27, No. 9.

flat-rolled finishing equipment

SHEARING LINES

SIDE TRIMMING, SLITTING AND RECOILING LINES

LEVELING AND OILING LINES

CONTINUOUS GALVANIZING LINES

CONTINUOUS TERNE LINES

CONTINUOUS TIN LINES

Flat-Rolled Finishing has come a long way in the last 25 years. During this time, Aetna-Standard has worked closely with the industry's specialists in pioneering many new ideas, such as: continuous galvanizing, continuous terne lines, high speed shearing and classifying lines and backed-up Roller Levelers.

Through its many achievements and work with the industry, Aetna-Standard is regarded as the leader in the designing, engineering and building of Flat-Rolled Finishing Equipment.

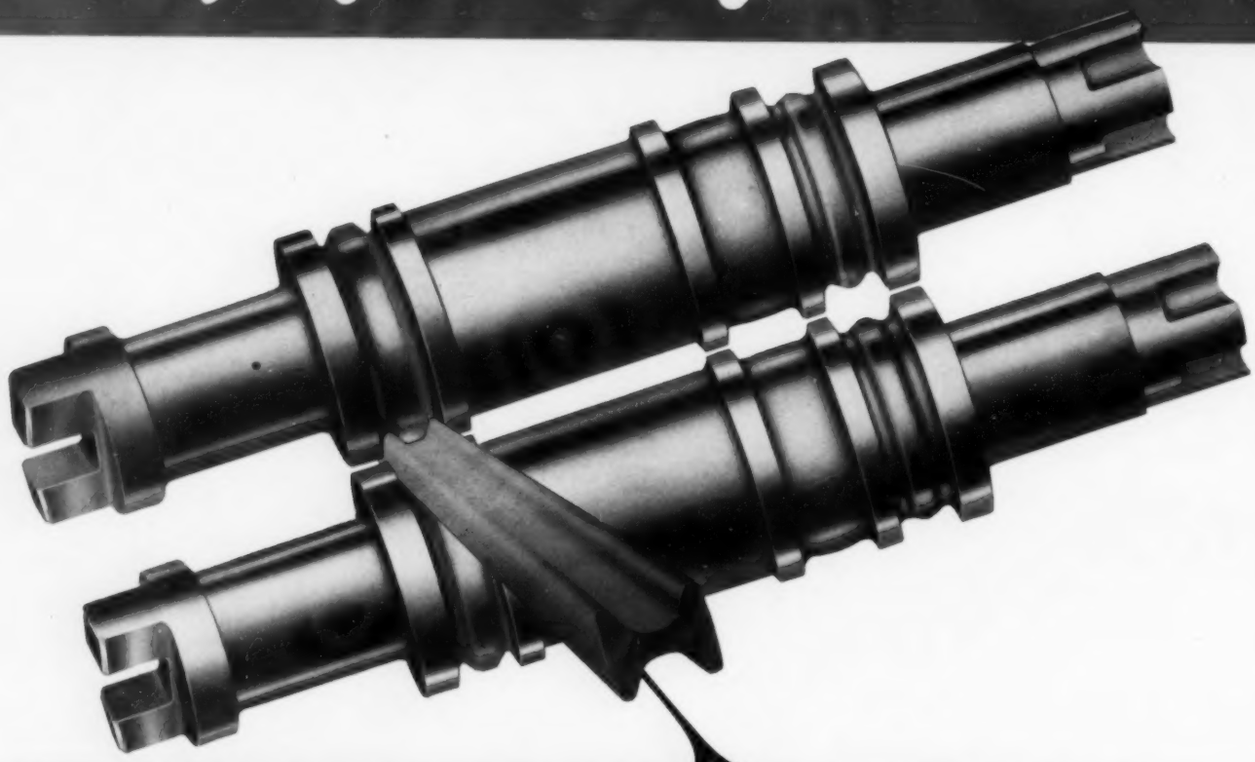
THE AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

ASSOCIATED COMPANIES:

AETNA-STANDARD ENGINEERING CO., LTD. TORONTO, ONTARIO, CANADA
HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND
SOCIETE DE CONSTRUCTIONS DE MONTBARD, 6 RUE DARU, PARIS (8e) FRANCE

Technique for Rolling Bloom Blanks



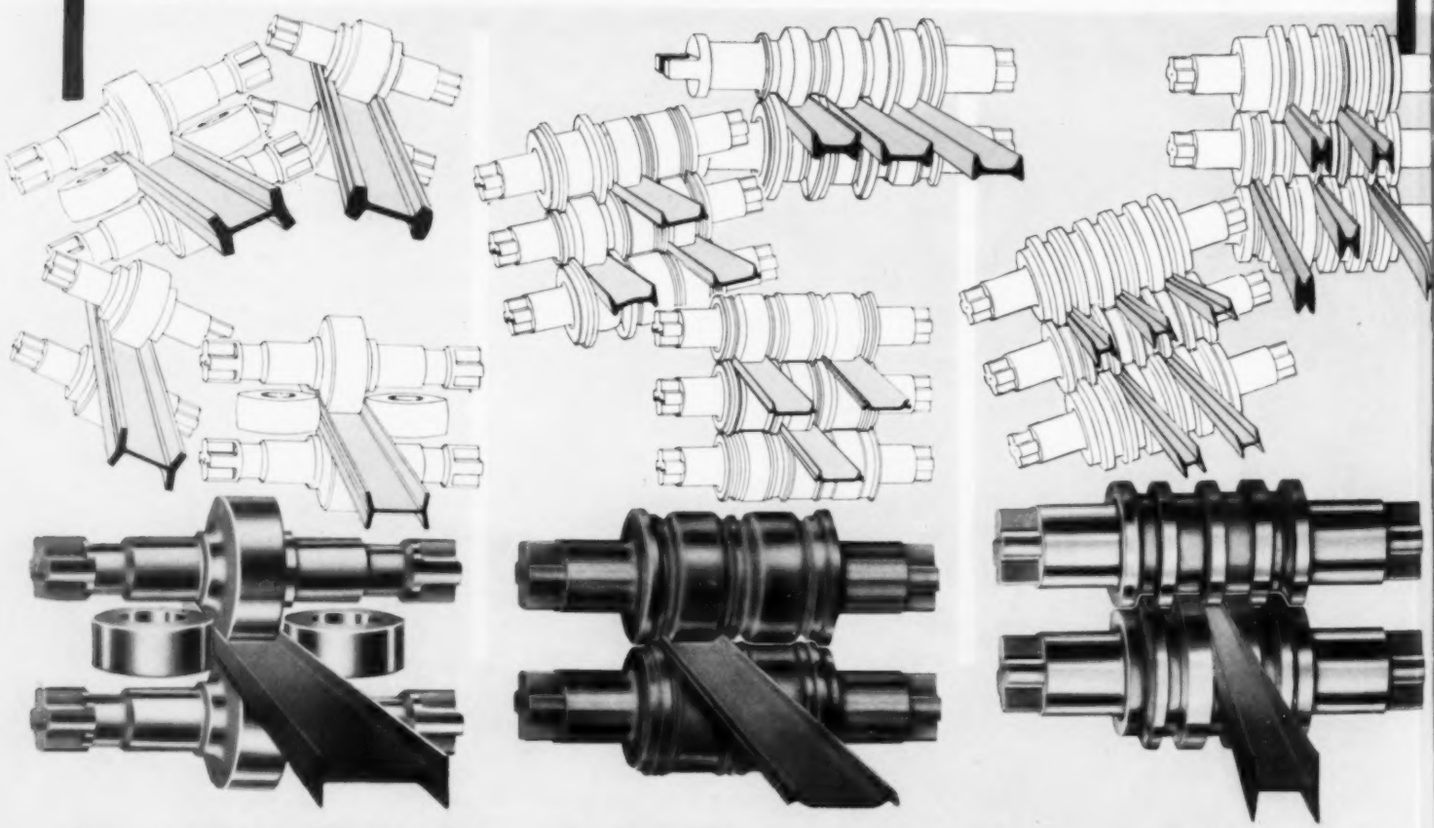
UNIVERSAL SHAPES

BEAMS

PILING BARS

CHANNELS

"H" BEAMS



PITTSBURGH

...and Slabs into Finished Products...

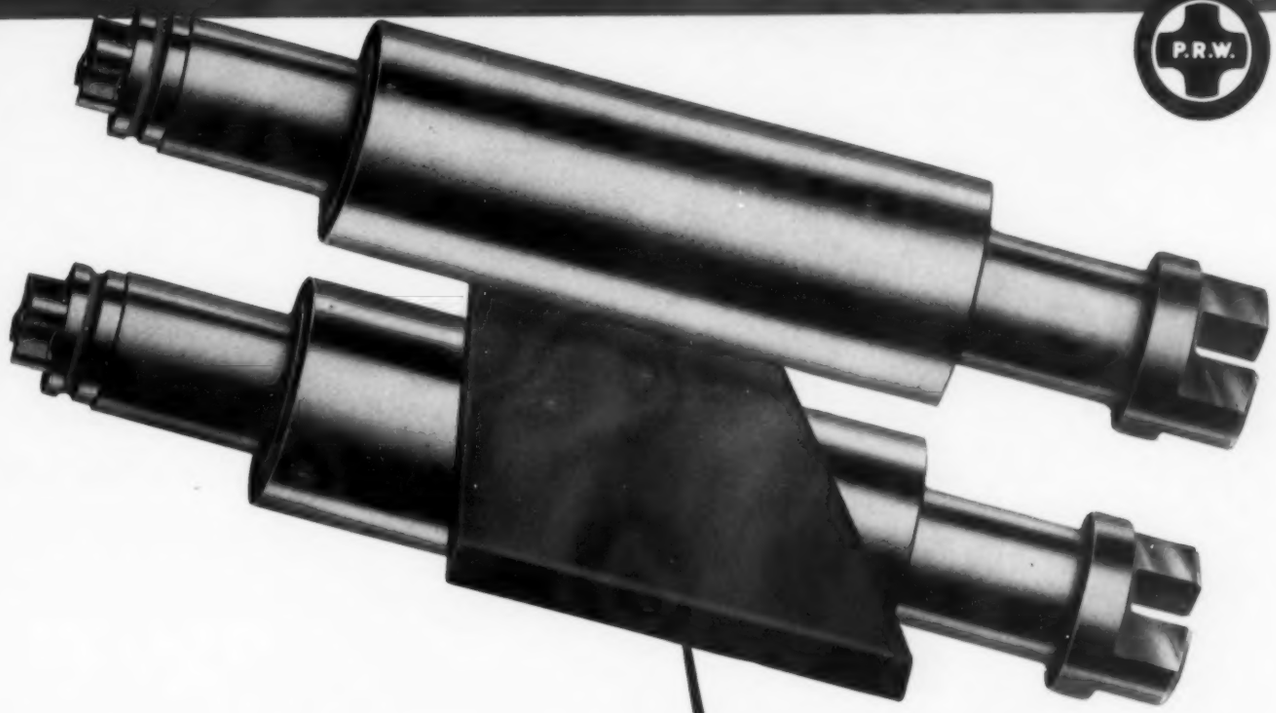
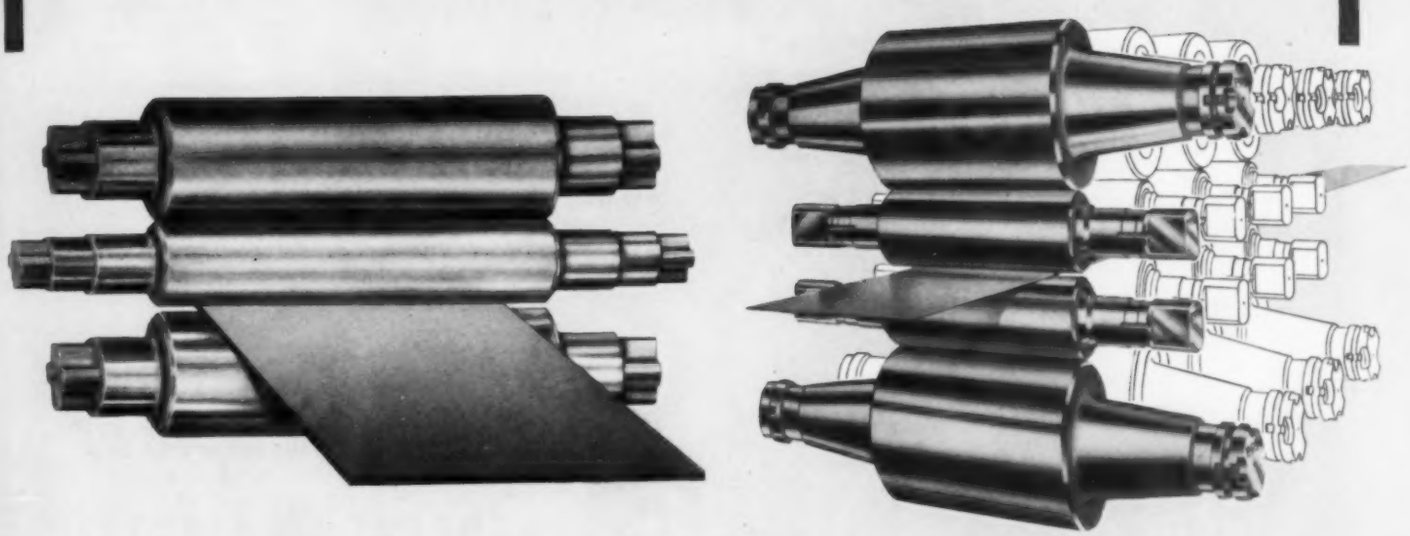


PLATE FLOOR PLATE SHEET STRIP

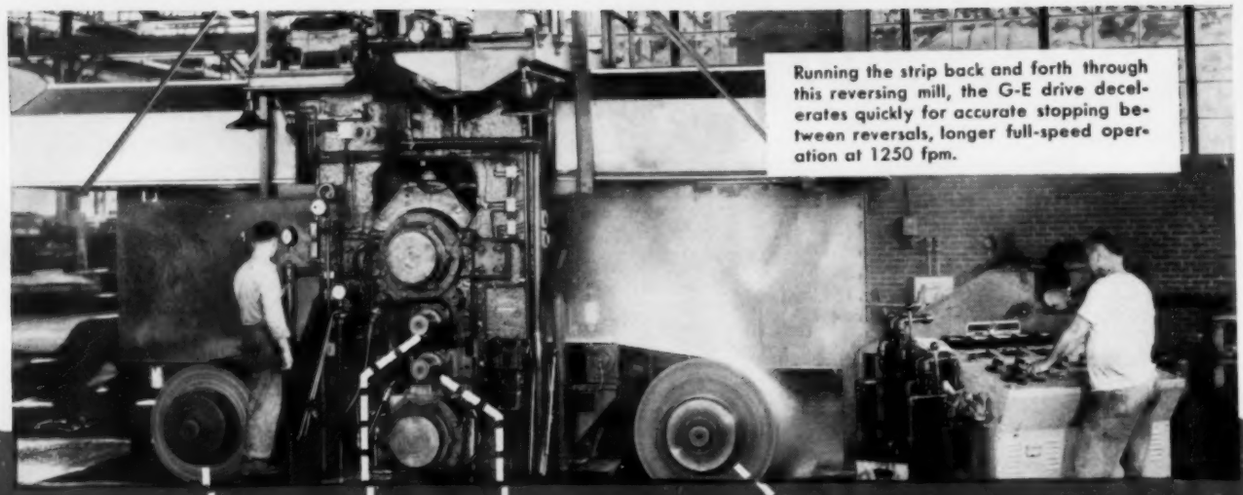


Pittsburgh Grade alloy iron work rolls and Phoenix "A" alloy steel back-up rolls in four high strip mills produce highest tonnages at *less cost per ton of steel rolled.*

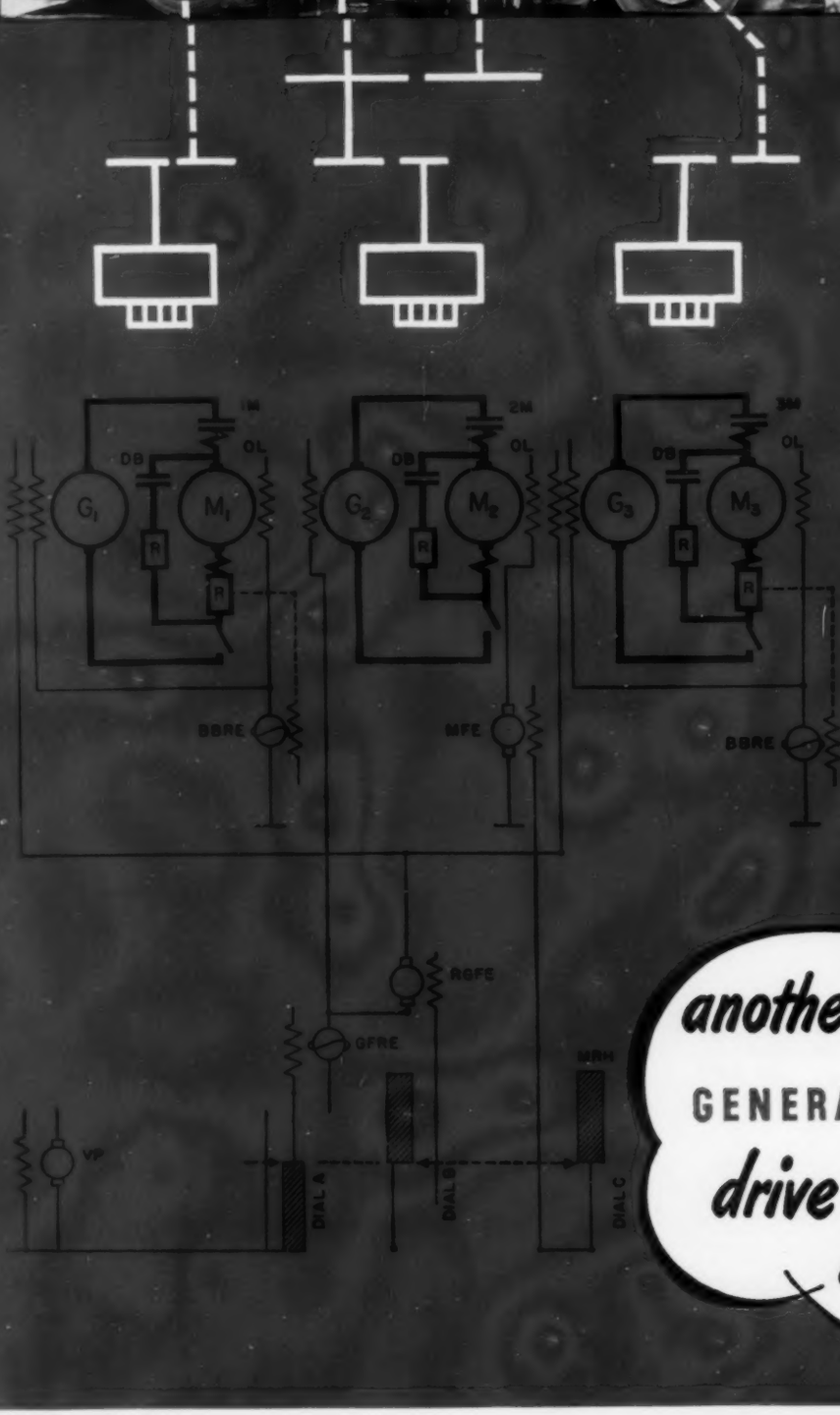
ROLLS

DIVISION OF BLAW-KNOX CO.

PITTSBURGH 1, PENNSYLVANIA



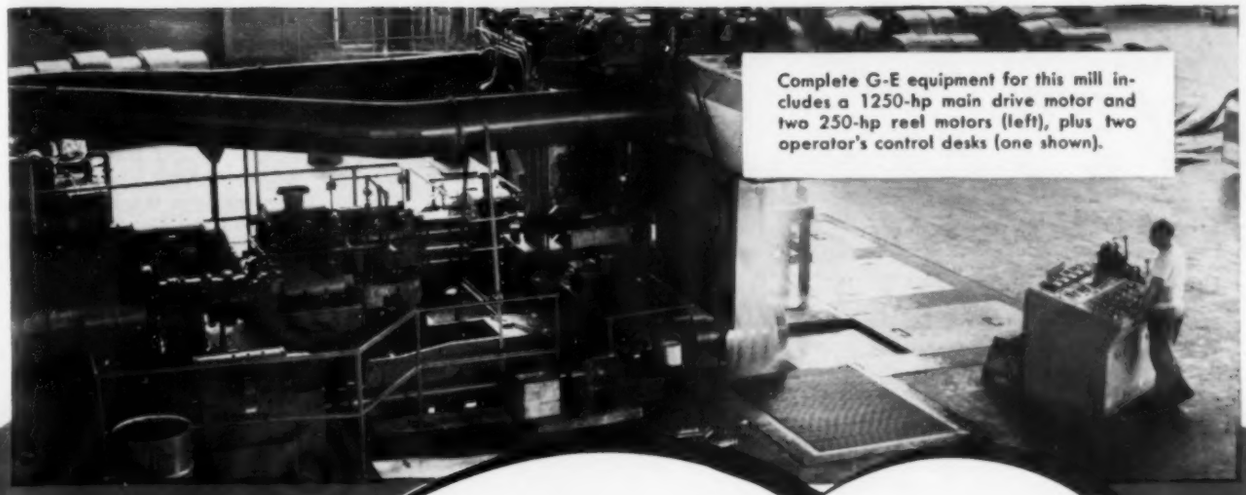
Running the strip back and forth through this reversing mill, the G-E drive decelerates quickly for accurate stopping between reversals, longer full-speed operation at 1250 fpm.



HOW THIS MILL WORKS

Speed of the mill is set by the speed of the main motor (M_2). This speed is controlled by generator (G_2) voltage up to base speed. Voltage is regulated to a value set by the motor operated rheostat (MRH) through an amplidyne exciter (GFRE). Speeds above base speed are obtained through field weakening by adjusting the motor field exciter (MFE) voltage. The reel motors (M_1) and (M_3) stay synchronized with (M_2) at all times by pulling or dragging with substantially constant tension. This is assured by adjusting the voltage of the reel generators (G_1 and G_3) to a value proportional to the strip speed, through a combination of the output of the amplidyne (GFRE) and the reel generator field exciter (RGFE). The armature current of the reel motors (M_1) and (M_3) is controlled by an amplidyne (BBRE) which acts to buck or boost the shunt field.

another example of
GENERAL ELECTRIC
drive engineering at work!



Complete G-E equipment for this mill includes a 1250-hp main drive motor and two 250-hp reel motors (left), plus two operator's control desks (one shown).

G-E drive for 24" reversing cold-strip mill

maintains strip uniformity, simplifies threading and jogging, boosts "on gage" tonnage!

Here's another in a long list of General Electric steel-mill drives engineered for close quality control, ease of operation, and high output. Installed on a 24" 4-high reversing cold-strip mill in Detroit Steel Corporation's Eastern Mill Division, New Haven, Conn., this drive:

Holds uniform tension at all speeds, which provides uniform gage and surface, reduces strip breakage and roll marking.

Operates either unit independently, in either direction, without disturbing the other. This simplifies threading, permits holding stalled tension on one reel while jogging the other into position.

Accelerates and decelerates rapidly at a uniform, reliable rate from any speed, assuring accurate stopping between reversals, longer operation at top speed. Strip gets "on-gage" faster, stays "on-gage" longer!

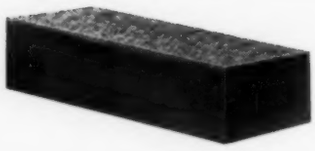
It's one more example of General Electric's ability to handle *your* steel-mill drive problems successfully. Why not ask a G-E steel-mill specialist to discuss them with your engineers? *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

skill experience and manufacturing facilities **these account for the Superior**

CHROMEX B—an extremely hard fired chrome-magnesite refractory having unusual constancy of volume and strength at high temperatures.

METALKASE—the pioneer metal encased basic brick possessing an unusual combination of desirable properties.



CHROMEX—a chemically bonded chrome-magnesite brick having excellent spalling resistance.

MAGNEX—a chemically bonded magnesite-chrome brick—highly basic and of low spalling tendency.

H-W MAGNESITE—the standard burned magnesite refractory in the steel industry for more than half a century.

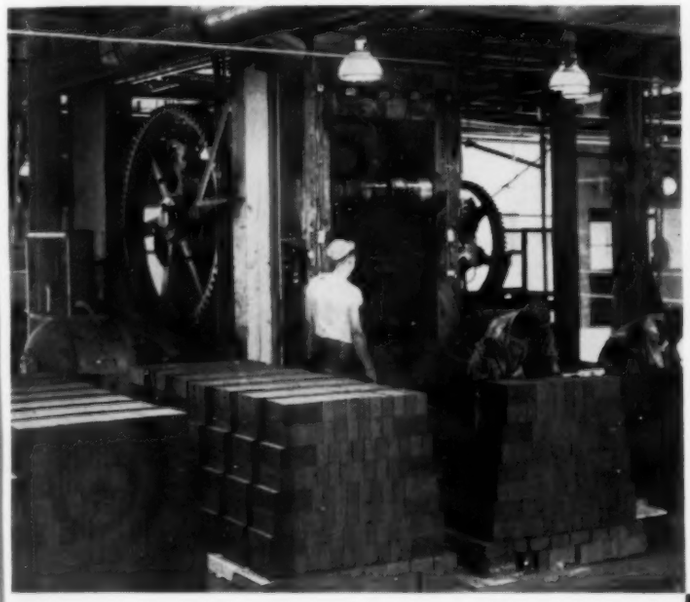
THERMAG—a hard burned magnesite-chrome refractory possessing enhanced physical properties.

H-W CHROME—a hard burned chrome brick especially adapted for various specific uses.

FORSTERITE—the only commercially produced magnesium-silicate brick—suited for certain particular applications.

H-W PERIKLASE—an exceptional high-magnesia brick of unusual high-temperature stability.

Quality of HARBISON-WALKER *basic* REFRACTORIES



Ever since the introduction of the basic process for making open-hearth steel, Harbison-Walker has led in the development and manufacture of basic refractories. Some of these products are listed here.

The superior performance of Harbison-Walker basic refractories is the result of: (1) a thorough knowledge of the requirements of the basic process, gained through close cooperation with steel producers; (2) extensive and continuous original research conducted by the Harbison-Walker Research Department; and (3) top quality raw materials processed in modern plants under close laboratory control. Harbison-Walker uses the most up-to-date methods and equipment to insure the quality and uniformity of basic refractories.

(*Above*) This modern brick pressing machine at the new Baltimore, Maryland plant is typical of the most effective equipment used in the manufacture of Harbison-Walker products.

(*Left*) Harbison-Walker research studies of compositions and manufacture of basic refractories and their performance under operating conditions are augmented with X-ray equipment.

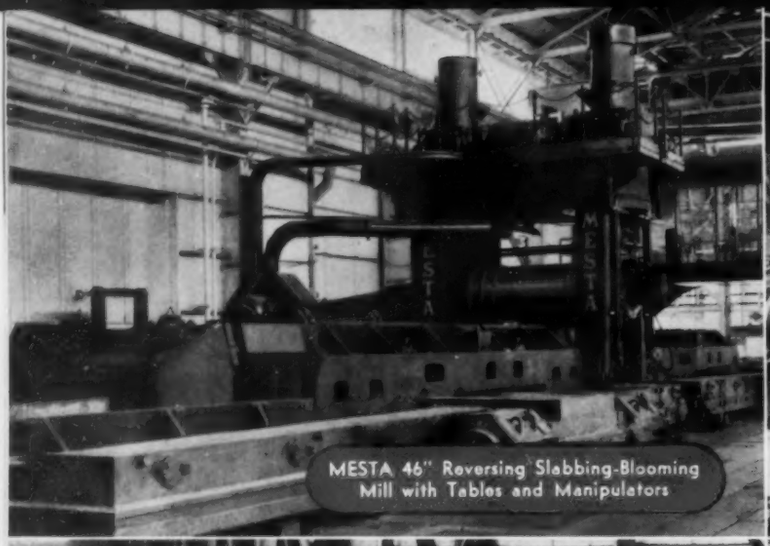
(*Right*) The dependable uniformity of Harbison-Walker products is assured by the use of the most accurate instrument-controlled equipment. Tunnel kiln cars leaving dryers for kiln.

OTHER HARBISON-WALKER BASIC REFRACTORIES

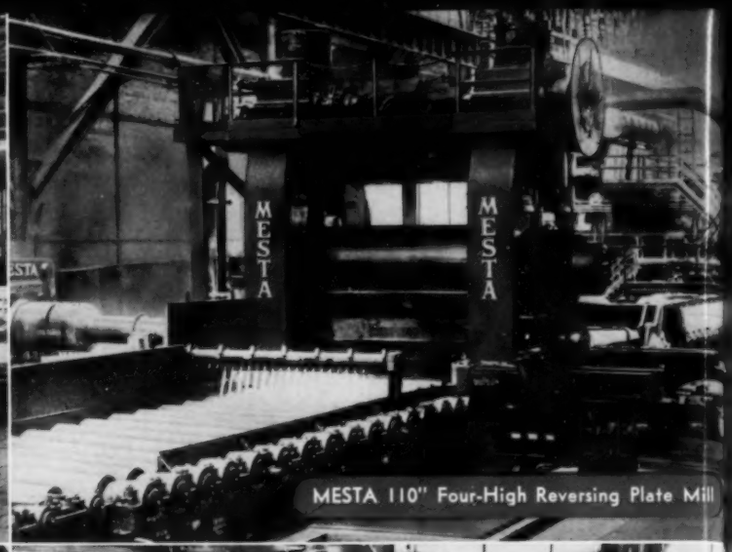
H-W Magnamix
H-W Washington Dead Burned Magnesite Grains
H-W Washington Furnace Magnesite
H-W Special Furnace Chrome
Plastic Thermolith Batch
Thermolith and Other Cements

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
World's Largest Producer of Refractories
GENERAL OFFICES • PITTSBURGH 22, PA.

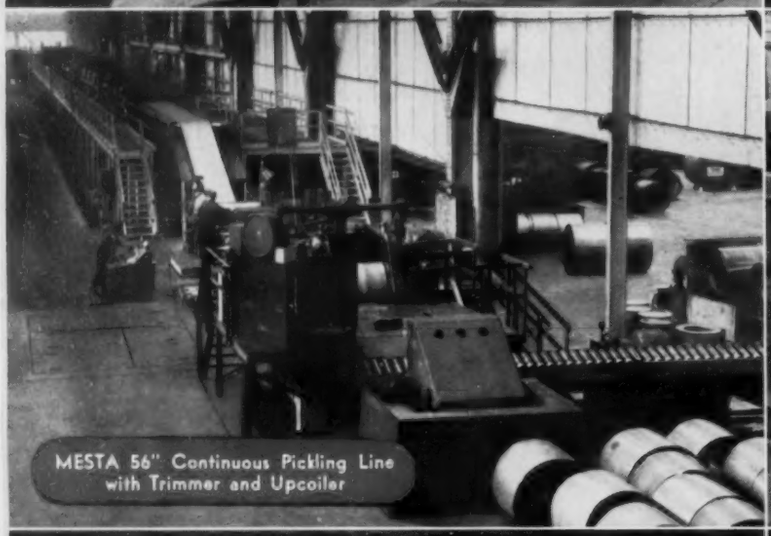
®



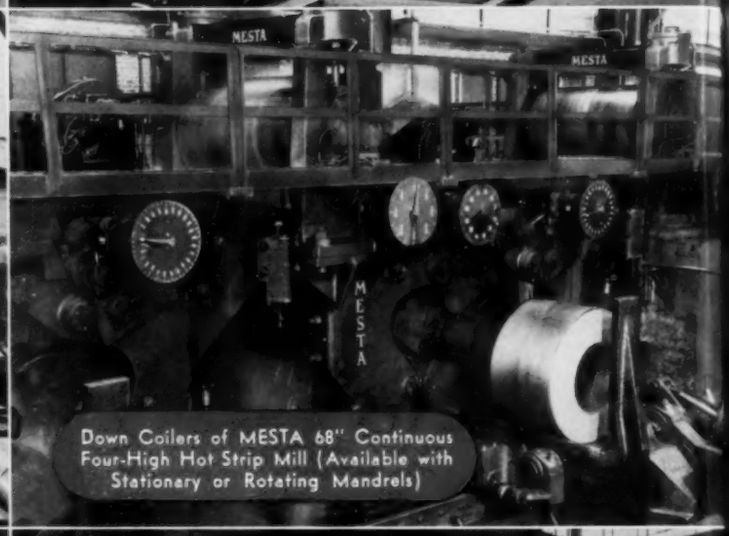
MESTA 46" Reversing Slabbing-Blooming Mill with Tables and Manipulators



MESTA 110" Four-High Reversing Plate Mill



MESTA 56" Continuous Pickling Line with Trimmer and Upcoiler

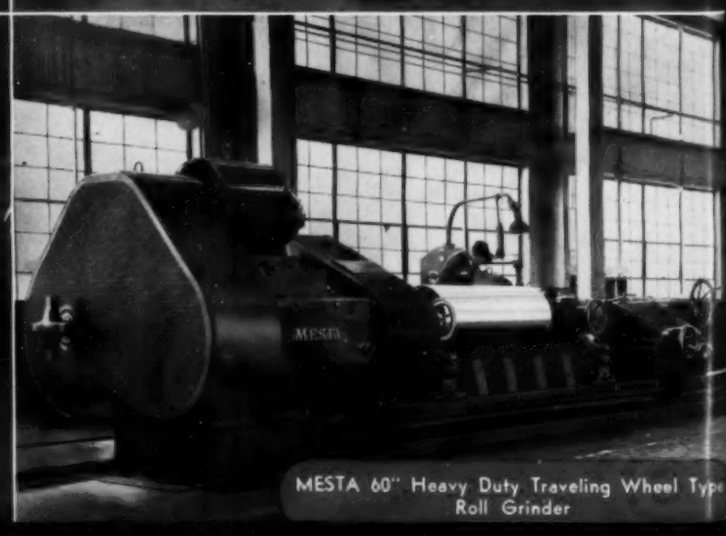


Down Coilers of MESTA 68" Continuous Four-High Hot Strip Mill (Available with Stationary or Rotating Mandrels)

Battery of Five MESTA 42" High-Speed Electrolytic Cleaning Lines

Machining Forged Steel Pressure Vessel for a MESTA 18,000 Ton Hydraulic Press on a MESTA Heavy Duty Lathe

MESTA 59"x 130" Heat Treated Special Alloy Steel Backing-up Roll Being Finished in a MESTA Heavy Duty Grinder



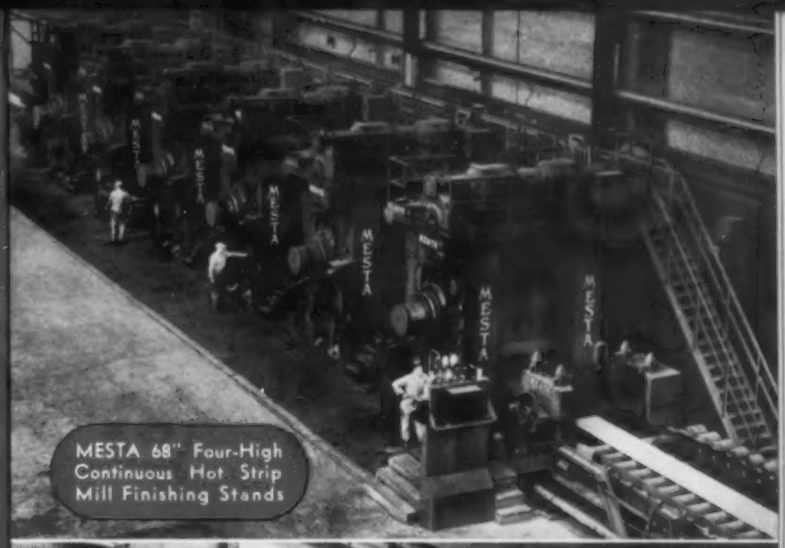
MESTA 60" Heavy Duty Traveling Wheel Type Roll Grinder

Designed and Built By

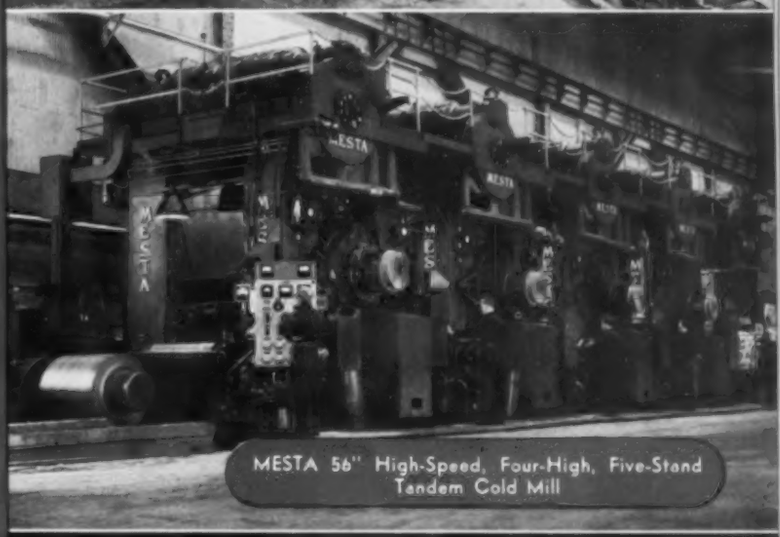
MESTA

MACHINE COMPANY

PITTSBURGH, PENNA.

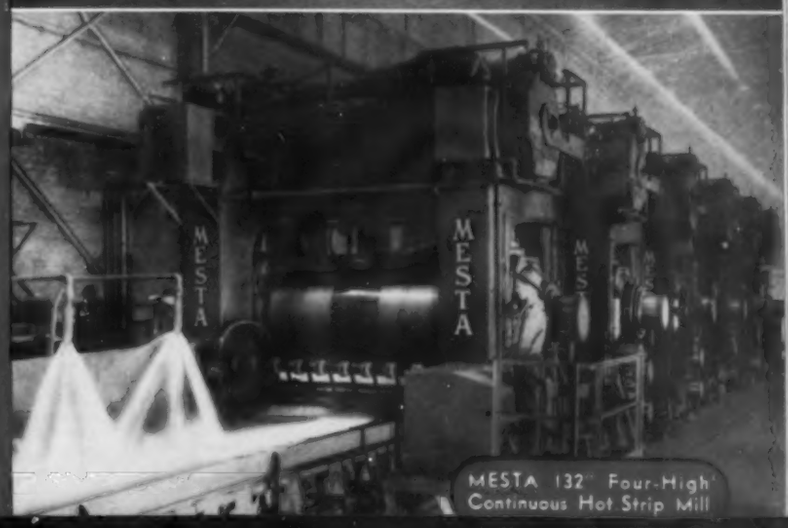


MESTA 68" Four-High Continuous Hot Strip Mill Finishing Stands



MESTA 56" High-Speed, Four-High, Five-Stand Tandem Cold Mill

MESTA 93" Four-High, Three-Stand Tandem Cold Reduction Mill

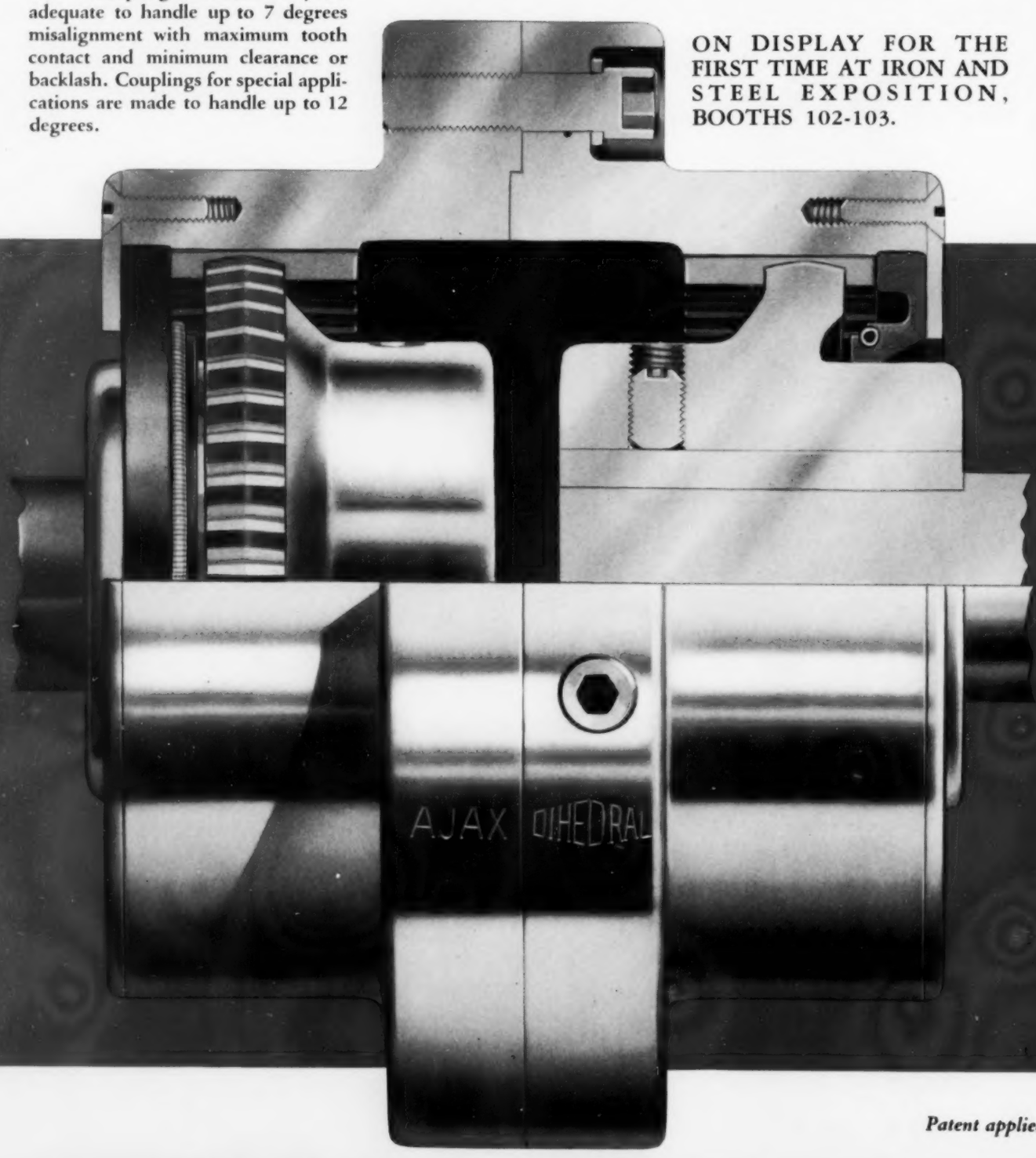


MESTA 132" Four-High Continuous Hot Strip Mill

Announcing AJAX DIHEDRAL

* Cutaway view of standard Dihedral Coupling shows how they are adequate to handle up to 7 degrees misalignment with maximum tooth contact and minimum clearance or backlash. Couplings for special applications are made to handle up to 12 degrees.

ON DISPLAY FOR THE FIRST TIME AT IRON AND STEEL EXPOSITION, BOOTHS 102-103.



Patent applied for

AJAX FLEXIBLE COUPLING CO. INC.

COUPLINGS

Designed to Handle Misalignment up to 12°

● Development of the Ajax Dihedral Coupling provides design engineers, installation and maintenance men with a revolutionary new flexible coupling for handling angular and offset misalignment encountered on roll mills . . . paper machinery . . . settling or heaving foundations . . . wooden floors . . . weaving structures such as coal tipples, earth moving equipment, well drilling rigs, high buildings, shipboard and many other installations.

Ajax Dihędral Couplings save thousands of dollars by eliminating necessity for precision alignment of driving and driven shafts.

Exclusive Ajax Dihedral tooth shape provides for maximum misalignment with minimum clearance or backlash.

Long life is assured because more tooth contact is maintained under operating conditions than with any other shaped tooth. 30° involute splines provide strong basic tooth form.

Positive oil seals keep lubrication in and dirt out.

Free end float permits electrical machinery to find its magnetic center.

Complete description and data on 8 sizes are given in our new Bulletin 50. Write for your copy.

Standard Dihedral Couplings made to handle up to . . . . . 7°

For special applications they are made to handle up to . . 12°

FLANGELESS SLEEVE TYPE

Specially designed for use on cluster and other types of roll mills where minimum O. D. and quick installation is essential.

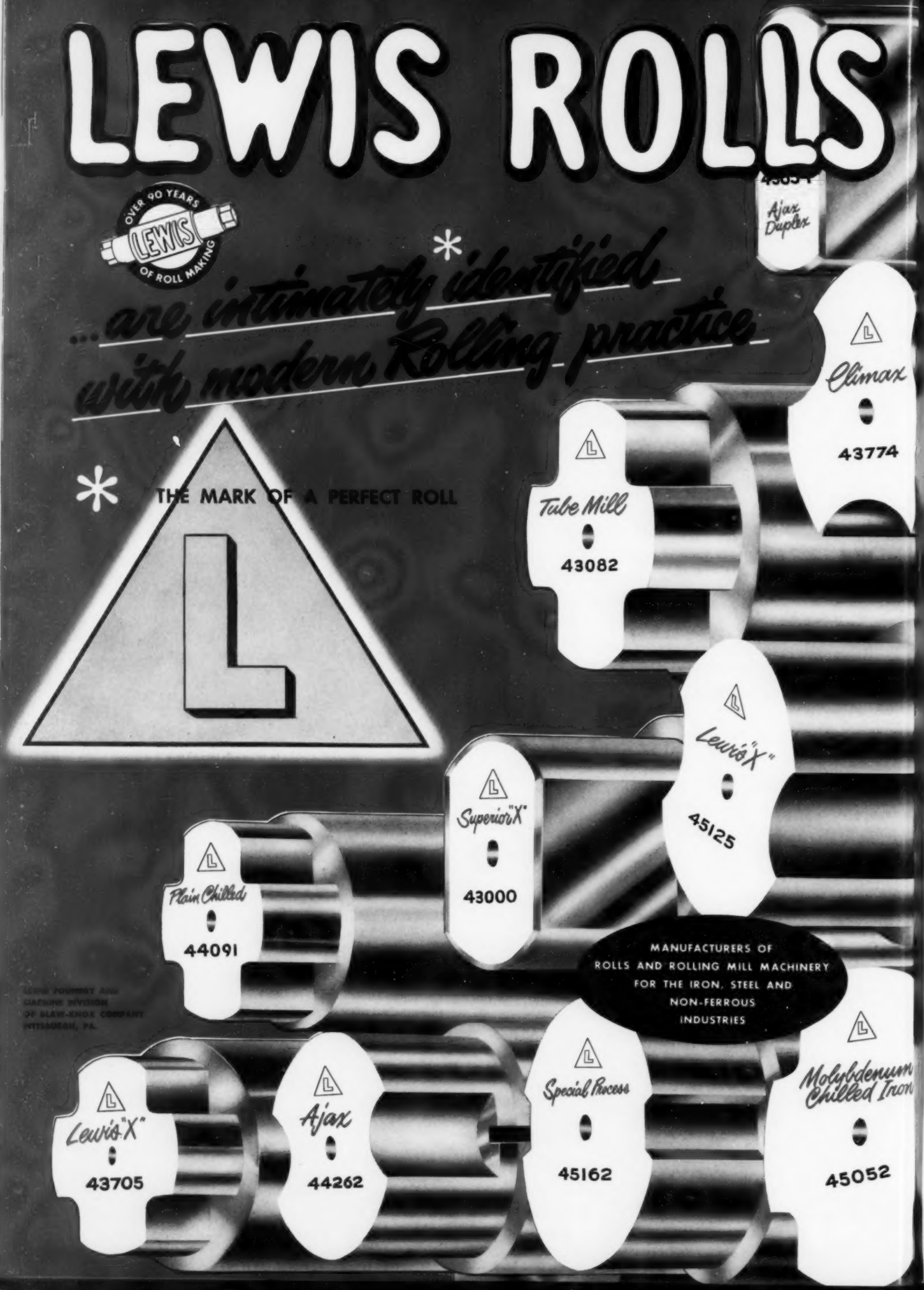
WESTFIELD, N.Y.

LEWIS ROLLS

OVER 90 YEARS LEWIS OF ROLL MAKING

...are intimately identified with modern Rolling practice

* THE MARK OF A PERFECT ROLL



MANUFACTURERS OF ROLLS AND ROLLING MILL MACHINERY FOR THE IRON, STEEL AND NON-FERROUS INDUSTRIES

LEWIS FOUNDRY AND MACHINE DIVISION OF BLAW-KNOX COMPANY PITTSBURGH, PA.

*EXTREME PRESSURE

All production machinery will last longer — give better service — if the proper lubricant is used. That's why you will find it profitable to use high quality Tycol oils and greases in your plant.

There's a reason! No matter what your lubricating need — *EXTREME PRESSURE, high or low temperature, high speed or any other service condition — there's a Tycol oil or grease suited to your specific requirements.

Refined from the highest grade crudes, Tycol lubricants are exceptionally resistant to breakdown which means greater economy . . . longer machine life for every type of equipment.

Tide Water Associated will gladly recommend the Tycol lubricant that meets your particular requirements. Call, write or wire your nearest Tide Water Associated office today.

TYCOL

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17 BATTERY PLACE · NEW YORK 4, N. Y.

*LEARN WHAT THIS PRODUCT CHARACTERISTIC MEANS TO YOU — READ "LUBRICANIA" This informative handbook, "Tide Water Associated Lubricania," gives clear, concise descriptions of the basic tests used to determine important properties of oils and greases. For your free copy, write to Tide Water Associated Oil Company, 17 Battery Place, New York 4, N. Y.

REFINERS AND MARKETERS OF VEEDOL — THE WORLD'S MOST FAMOUS MOTOR OIL

Recirculating Radiant Tube

ANNEALING FURNACES

One of many fine-performance features: the unique Swindell-Dressler *high velocity* burner, which gives better, more uniform distribution of heat in the tube . . . and very exceptional tube life with coke oven gases (2 to 3 times normal). *May we consult on your needs?*

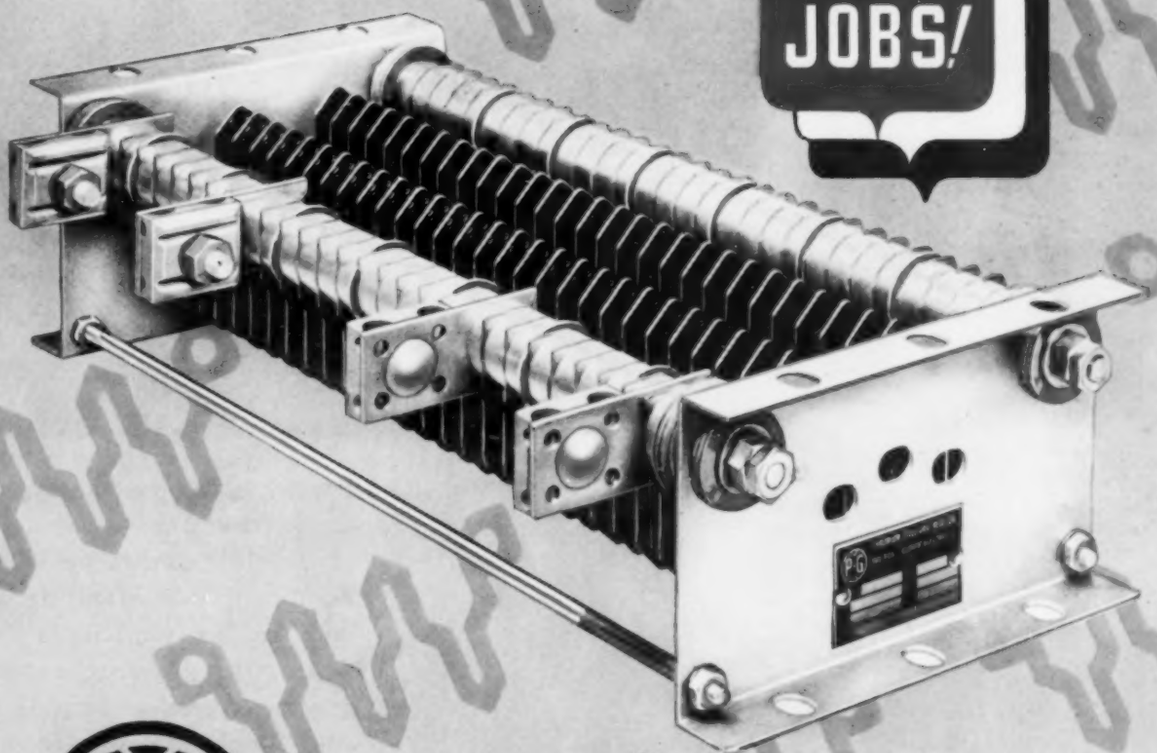
SWINDELL-DRESSLER *Corporation*

Designers and Builders of Modern Industrial Furnaces

PITTSBURGH 30 PENNA

P-G *Nonbreakable* STEEL GRID RESISTORS

For THOSE TOUGH JOBS!

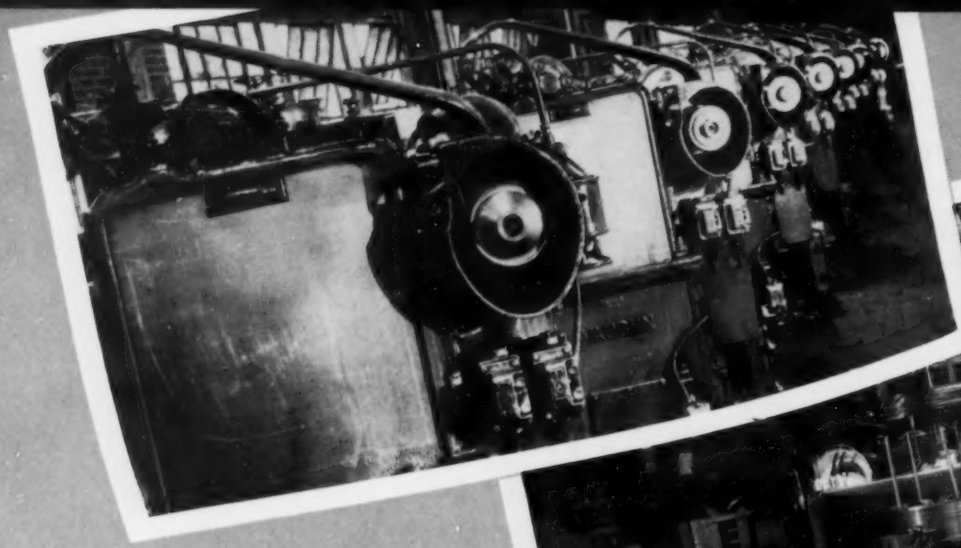


The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

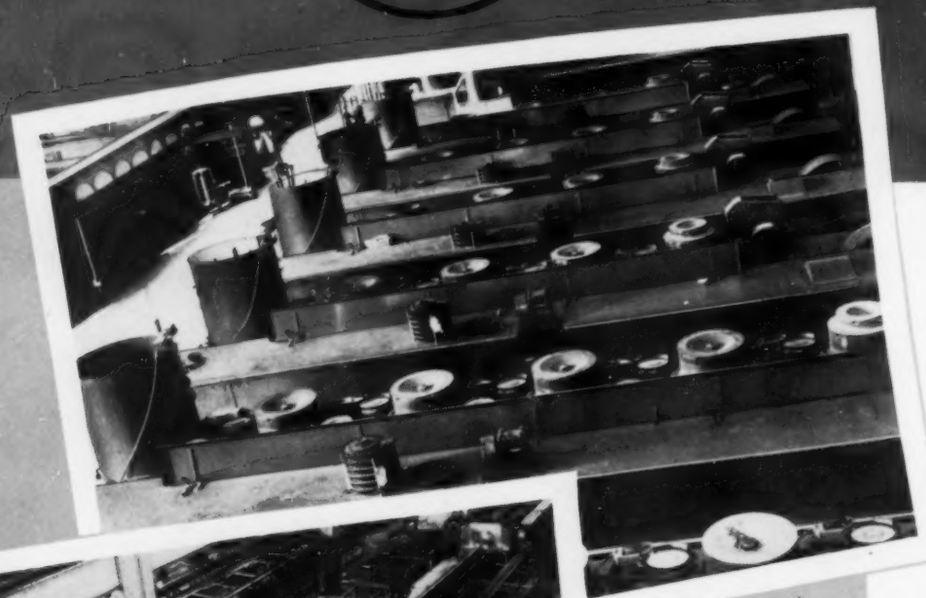


RINGBLOX
MOTOBLOC®

For Profit-Paced PRODUCTIVITY—

Vaughn®

COLD DRAWING EQUIPMENT



MOTOBLOX®
DRAW BENCHES

Proper *speed* is the keynote, *flexibility* and *versatility* are the supporting factors of Vaughn Equipment's outstanding productivity in service. • Name your cold drawing requirements, and let us detail a specific Vaughn program for most effective handling!

The VAUGHN MACHINERY COMPANY

CUYAHOGA FALLS, OHIO U. S. A.

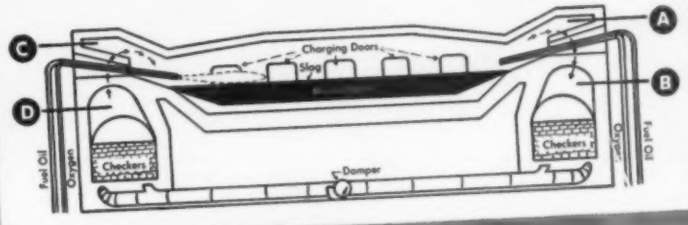
COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys

PRODUCTION BOOSTED

BY STRAIGHT ANSWERS FROM THIS REMARKABLE INSTRUMENT

"The way the Cities Service Heat Prover analyzed combustion atmospheres, we knew right off what to correct."
--Open Hearth Operator

Cities Service Heat Prover is applied at A and B—or C and D (on reverse cycle)



This highly developed flue gas analyzer gives correct reports on any type and size of furnace. Quickly, accurately and fully it lets you know how much fuel may be going to waste; whether there are combustibles, or excess oxygen to cause troubles like scaling; what combustion losses are due to useless heating of excess air. Corrections can then be made for added production efficiency. You can profit by this check-up service. Ask about arrangements.

For the Metal Fabricating Industry—
a complete line of petroleum products that includes:

Chillo Cutting Oils	**Pacemaker Hydraulic Oils**
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For complete details, mail coupon today and receive your copy of "Combustion Control for Industry."

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Please send me, without obligation, a copy of "Combustion Control for Industry."

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Hyde Park Rolls

ALLOY IRON and CHILLED

Rolling Mill Machinery

Gray Iron Castings

You will find the Red Circle only on Hyde Park Rolls. It is our pledge of quality, our guarantee of workmanship and of performance.

Hyde Park Rolls have proved themselves in service. For more than fifty years they have held the respect and the confidence of the industry. We shall do everything within our power to merit a continuance of that respect and confidence now and through the years ahead, striving always for higher perfection of both product and service.

Chilled and Alloy Iron, Moly, Nickel Chilled, Grain, Cold and Sand Rolls.

Rolling Mill Equipment including Mill Shears, Stretcher Levellers, Mill Reduction Drives, Sheet Pack Carriers, Roller Lathes, Gears, Pinions, Lay-out Tables, Surface Plates, Floor Plates, etc.

Visit our display — Booth No. 283 — Iron & Steel Exposition
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Hyde Park Foundry and Machine Co.

HYDE PARK Westmoreland County Pittsburgh District **PENNA.**

CHECK the R&IE FACTS

1 JAW CONTACT—Hi-Pressure, Hi-Thermal capacity silver to copper contact. ONLY ONE BREAK CONTACT ON THE SWITCH. Copper and beryllium jaw—copper for thermal capacity and beryllium for strength and resilience. Here's maximum protection against fault current damage.

2 HINGE CONTACT—Completely enclosed and weather sealed Hi-Pressure, Hi-Thermal capacity, silver to copper Hinge Contact. Continuous, annular, constant electrical and mechanical contact at all times. Eliminates second break contact with its multiplied problems and maintenance.

3 BLADE OPERATING MECHANISM—Simplified and "streamlined" to attain a simple harmonic, accurately controlled blade motion. Special pin fastenings, snap rings, and rivets have been eliminated from moving parts. Universal blade balance on 69 Kv. and above.

4 BLADE—Extra heavy, hard drawn tubular copper with integral, formed contact end. Solid current path from jaw to hinge contact.

5 TERMINALS—Four half-inch bolts on 1¾ x 1¾ inch centers permit NEMA standard 600 or 1200 Ampere clamping and R & IE Type "UC" universal clamps. Both terminals equal height from base.

6 BEARING—Aluminum housed, weather sealed, stainless ball—requires no lubrication.

The NEW TYPE TTR-49

34.5 Kv.
600 Ampere

Before you buy any switch that gives you less

CHECK the FACTS on TTR-49

A new conception of switch value

I-T-E R&IE

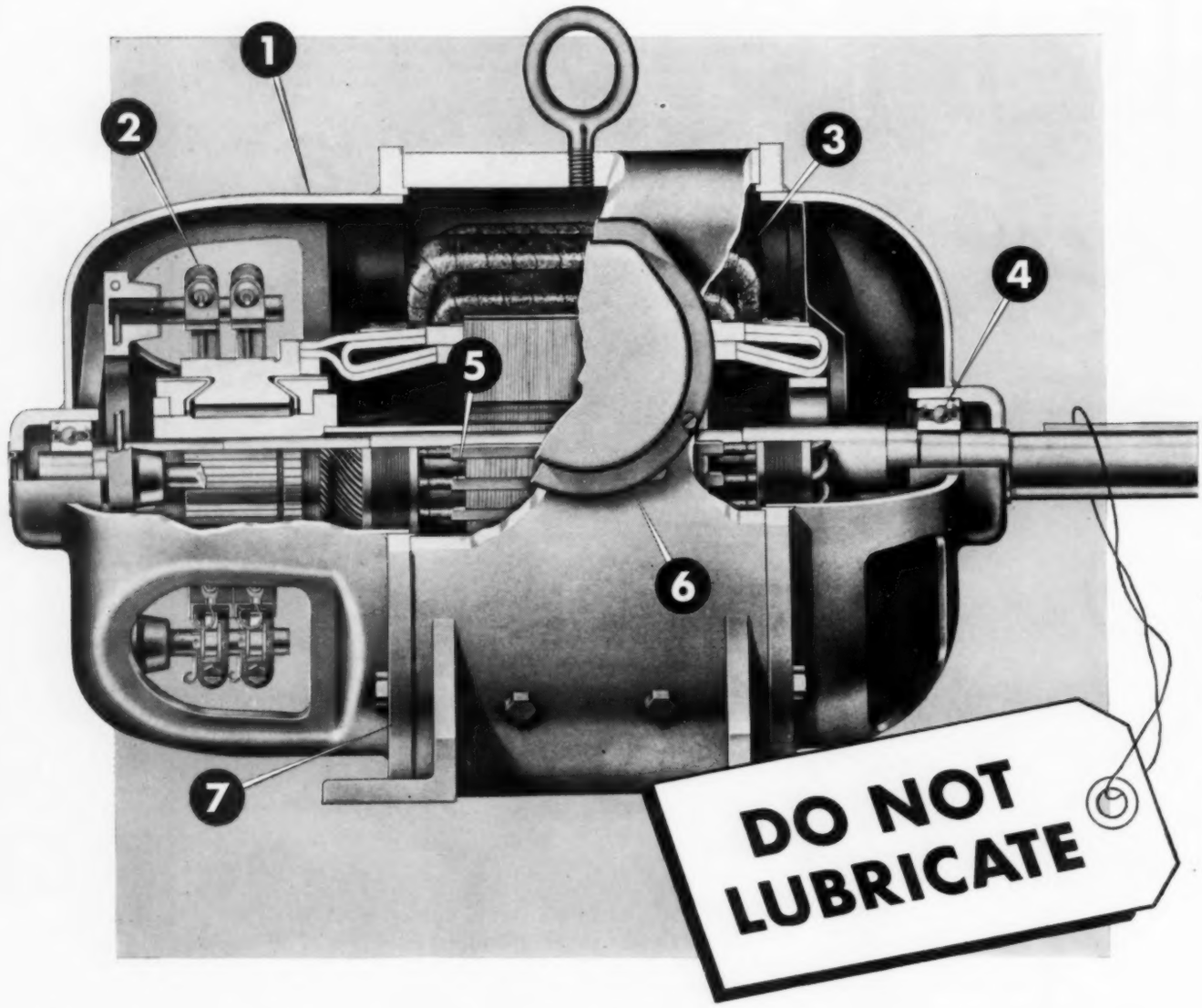
RAILWAY and INDUSTRIAL ENGINEERING CO., Greensburg, Pa.

IN CANADA—EASTERN POWER DEVICES LIMITED, TORONTO

AN I-T-E SUBSIDIARY

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



1. ALL-STEEL BRACKETS
2. INDIVIDUALLY REMOVED CAST BRASS BRUSHHOLDERS
3. SHELL-WOUND FIELD COILS
4. DOUBLE-SEALED PRE-LUBRICATED BALL BEARINGS
5. HEAVY-DUTY PRESHAPED ARMATURE COILS
6. STEEL-GASKETED CONDUIT BOX
7. ROLLED-STEEL FRAME

If you figure LIFE-COSTS . . . you'll figure LIFE-LINE

SK DEPENDABILITY
Wrapped in Steel
in the NEW *Life-Line* D-C MOTOR

Thirty-nine years at hard labor—in steel mills . . . in mines . . . in a thousand and one applications—have proved the dependability of the type SK d-c motor. Now, new dependability has been added—new motor stamina . . . new freedom from maintenance . . . new value for d-c motor users.

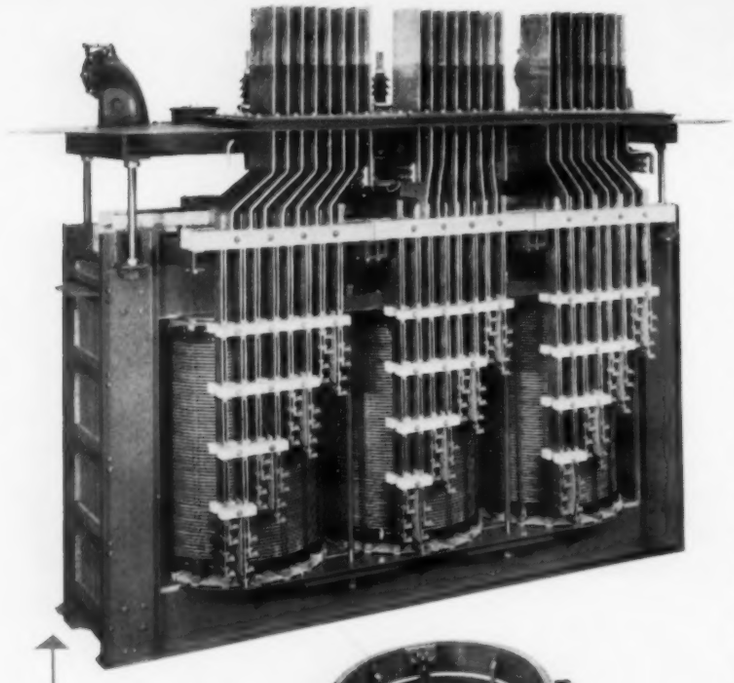
MAXIMUM STRENGTH AND RIGIDITY—Heavy steel end brackets and rolled-steel frame stand up to the shocking, jarring blows so often encountered in rugged d-c service.

SIMPLIFIED SERVICING—Readily accessible through spacious opening in front bracket, brushholders may be removed individually. Armature coils, wound from Tufvar wire and treated in Thermoset varnish assure long life . . . reduce trouble from shorts and grounds. Double-sealed pre-lubricated bearings (proved in over half a million motors) put an end to greasing problems.

INDIVIDUAL FIELD COIL UNITS—One coil may be replaced without expense of replacing all . . . or discarding pole piece. Just slip the new coil in place . . . save repair costs.

These are a few highlights of the new, all-steel Life-Line type SK d-c motor. Get the complete facts on series, shunt, or compound motors . . . frames 203-365 . . . in 1 to 30 hp ratings. Contact your local Westinghouse representative. Ask for a copy of "D-C Motor" Booklet B-4595, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21549

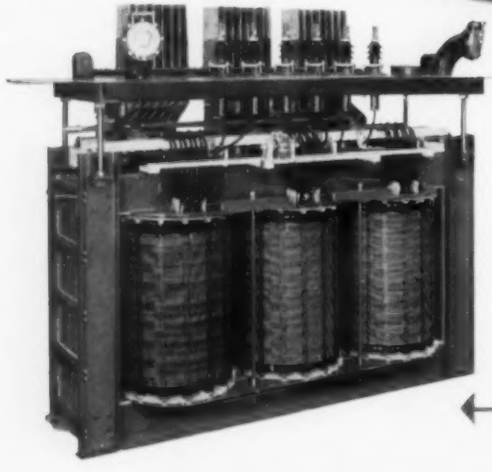
Westinghouse
Life-Line
D-C Motors



Low Voltage side. Note arrangement of bus bars.

12,000 Kva Furnace Transformer, 3 Phase, 60 Cycles, Water Cooled. High Voltage, 12,000 Volts. Low Voltage ranges from 375 down to 200 Volts, or full capacity. Maximum Low Voltage line current — 34,600 Amperes. High Voltage brought out with six bushings for star connection to obtain a lower range of low voltages.

Interior of tank showing arrangement of copper water cooling tubes.



High Voltage side. Pennsylvania's 3 Phase straight line tap changer mounted above core and coil unit can be quickly and easily inspected and maintained through cover manholes.

Recently installed 12,000 KVA Furnace Transformer raises total of PENNSYLVANIA FURNACE TRANSFORMERS in service to 1¼ MILLION KVA

When this 12,000 Kva Furnace Transformer was put into service, it brought the total installed Kva of Pennsylvania Furnace Transformers to over 1¼ million Kva.

The successful operation of Pennsylvania Furnace Transformers and their industry-wide acceptance indicate that Pennsylvania engineers fully understand the problems of electric furnaces and their relation to furnace transformers.

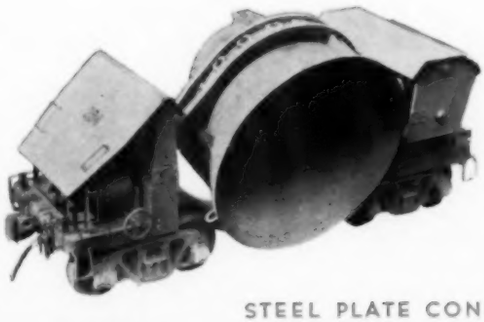
Pennsylvania TRANSFORMERS

Pennsylvania TRANSFORMER COMPANY

CANONSBURG, PENNA. • Greater Pittsburgh District

Hundreds of POLLOCK *Cinder Cars* IN SERVICE

Daily operating in well-known steel plants throughout the world, Pollock welded Cinder Cars efficiently handle hot slag and cinder with a minimum of maintenance. With unbelievable service records, Pollock Cinder Cars resist extraordinary stresses from buffing, and from bumping the pot to dislodge skulls. Select air, steam or electric drives—all give highly efficient dumping performance. Cars can be equipped with hand brakes or air brakes. Couplers, trucks, brakes, etc., are A.A.R. standard equipment. Single or double pot. Pollock Cinder Cars are tailored to your own plant's needs. Phone or write today for complete information.



There are more Pollock Cinder Cars
and Hot Metal Cars
in service
than any other make.

THE WILLIAM B. POLLOCK CO.

YOUNGSTOWN, OHIO

STEEL PLATE CONSTRUCTION · ENGINEERS · FABRICATORS · ERECTORS

BLAST FURNACES · HOT METAL CARS AND LADLES · CINDER AND SLAG CARS · INGOT MOULD CARS · CHARGING BOX CARS · WELDED OPEN HEARTH LADLES

THE RIGHT

...For Your Furnace

No one controller can properly regulate *all* furnaces or correctly govern the heat treatment for *all* products. The *right* control must be determined by the *type of furnace and the size, shape and metallurgical requirements of the product.* In the complete Brown line there is a control form best suited to *your* furnace and *your* product . . . function-fitted to your needs.

Newest additions to the Brown line are the *Electr-O-Line* and *Electr-O-Pulse* proportional control relays. For detailed information, as well as for a discussion of function-fitted control for all of your heat-processing requirements, call in your local Honeywell engineer . . . he is as near as your phone. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

FEATURING THE NEW

Electr-O-Line and Electr-O-Pulse

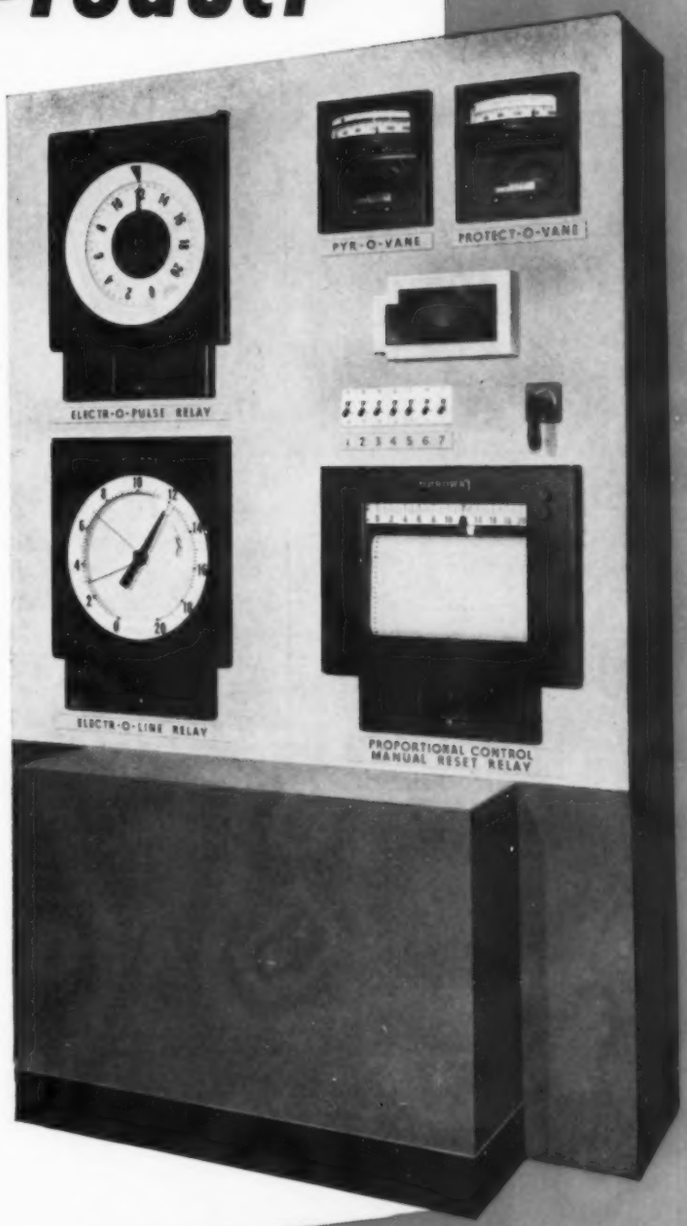
PROPORTIONAL CONTROL RELAYS

- The *Electr-O-Line* delivers a steady, modulated heat input.
- The *Electr-O-Pulse* delivers a time-modulated heat input.

CONTROLLER

...For Your Product

ON DISPLAY AND DEMONSTRATED AT THE IRON & STEEL EXPOSITION BOOTHS 314-15-16



All Brown electric control forms take full advantage of the extreme sensitivity and rapid response of the famous *ElectroniK* Potentiometer . . . circular scale, circular chart and strip chart. You can see them all . . . plus the *Pyr-O-Vane* millivoltmeter controller and the *Protect-O-Vane* excess temperature cutoff . . . at the Iron & Steel Exposition.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

Modernization is a *Must!*

USE BILLETEERS!

Resounding hammer of the village blacksmith rings through early American industrial history. But would you trade your modern forging equipment for a brawny arm and a heavy sledge? *No! —Not for a whole battery of them!* In billet-cleaning, like forging, new methods pay handsomely. Here's how today's proven production of the Bonnot Billeteer stacks up against out-moded hand methods of billet-conditioning.

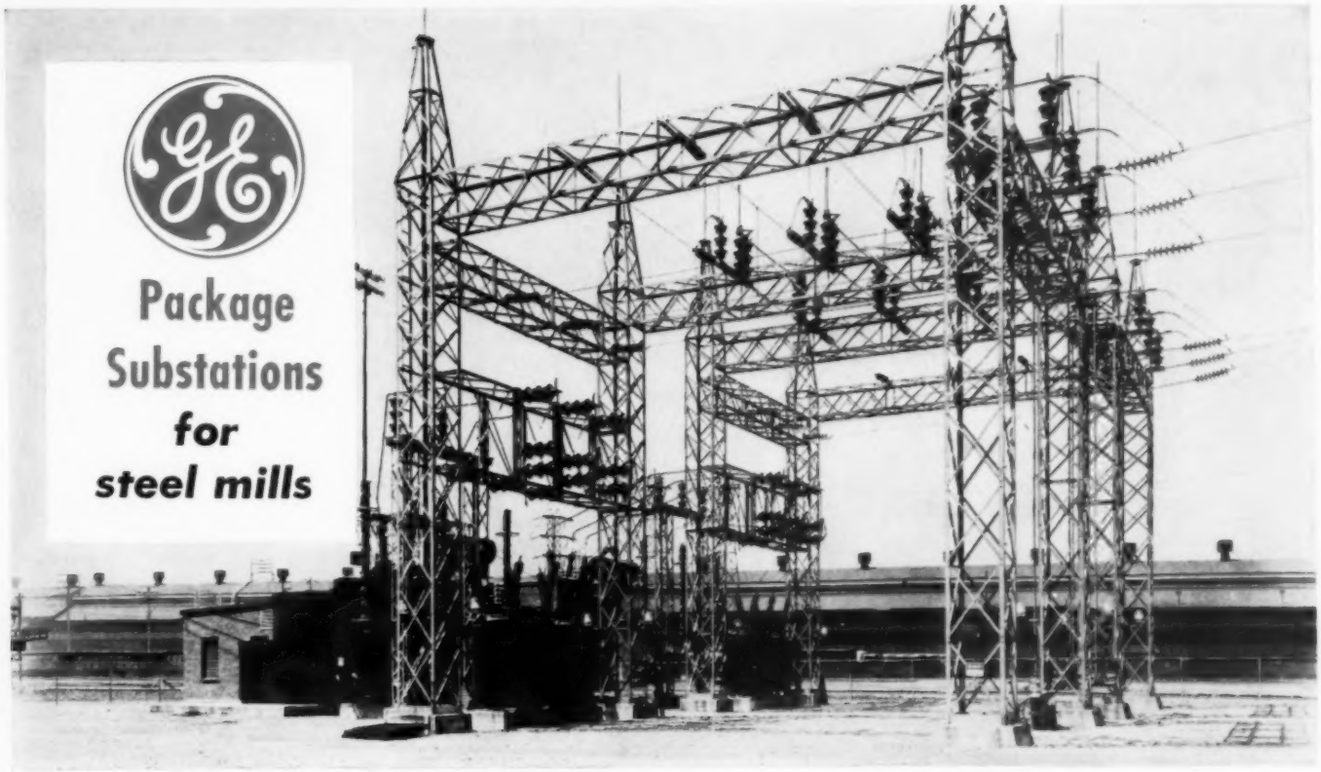
Engineered for Improved Production . . .

MANUAL CHIPPING	BILLETEER CONDITIONING
Labor costs high.	Labor costs reduced as much as 56%.
Slow, grueling operation.	Easy machine operation; does better work ten times faster.
Partial chip salvage.	Chips 100% recoverable.
Extremely hazardous.	Outstanding safety records such as 490,000 manhours with only one disabling accident.
Large inventory needed.	Minimum inventory and dependable, scheduled production.
Employee turnover high.	Fewer personal problems because men like to operate Billeteers.
Jitters and fatigue drastically limit span of worker's usefulness.	By contrast, rugged Billeteer stands the punishment—in many cases exceeding 100,000 hours of efficient performance, and with no absenteeism.

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

Let us show you how much the Bonnot Billeteer can save you in billet-conditioning and manpower costs — *Write today!*

ALSO MANUFACTURERS OF SAWING • CRUSHING • PULVERIZING & MIXING EQUIPMENT
BILLET INSPECTION TABLES • DUST PAD MILLS • SINTER PLANT PUG MILLS



Installed at a large steel mill, this G-E Package Substation contains 115-kv primary switching structure with oil circuit breakers, two 15,000-kva transformers, and 13.8-kv metal-clad switchgear with magne-blast breakers.

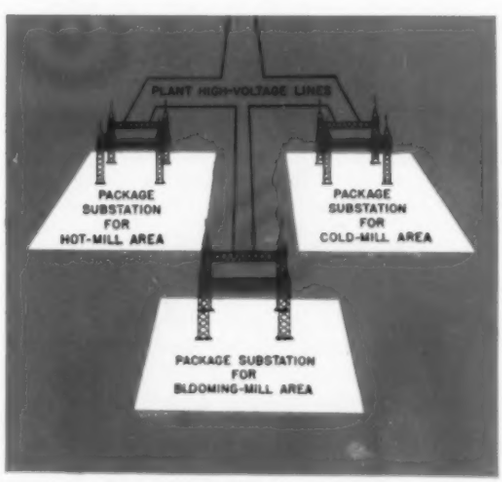
Cut system costs in high-voltage transmission

Co-ordinated G-E substations in 33-kv or 69-kv systems for large, multiple-area steel mills reduce installation costs and over-all system investment.

Here's a way to cut power distribution costs—using General Electric Package Substations—for large steel mills comprising several mill areas separated by relatively long distances. It applies the well-known load-center distribution system and its advantages—reduced voltage drop, lower power losses, less low-voltage cable, and lower system costs—to the higher voltages required by steel mills.

All in one cost-saving package! A G-E Package Substation combines *all* the electric equipment needed at each step-down point—switching structure, transformers, and metal-clad switchgear. Ordered, designed, and built as a unit, this cost-saver comes complete, co-ordinated, ready to install. You save engineering time, installation expenses, and over-all system costs. For more data, call your nearest G-E office, or send for Bulletin GEA-4500. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

Be sure to see "Modern Industrial Power Distribution," General Electric's "More Power to America" full-color sound slidefilm. Ask your G-E representative to arrange a showing.

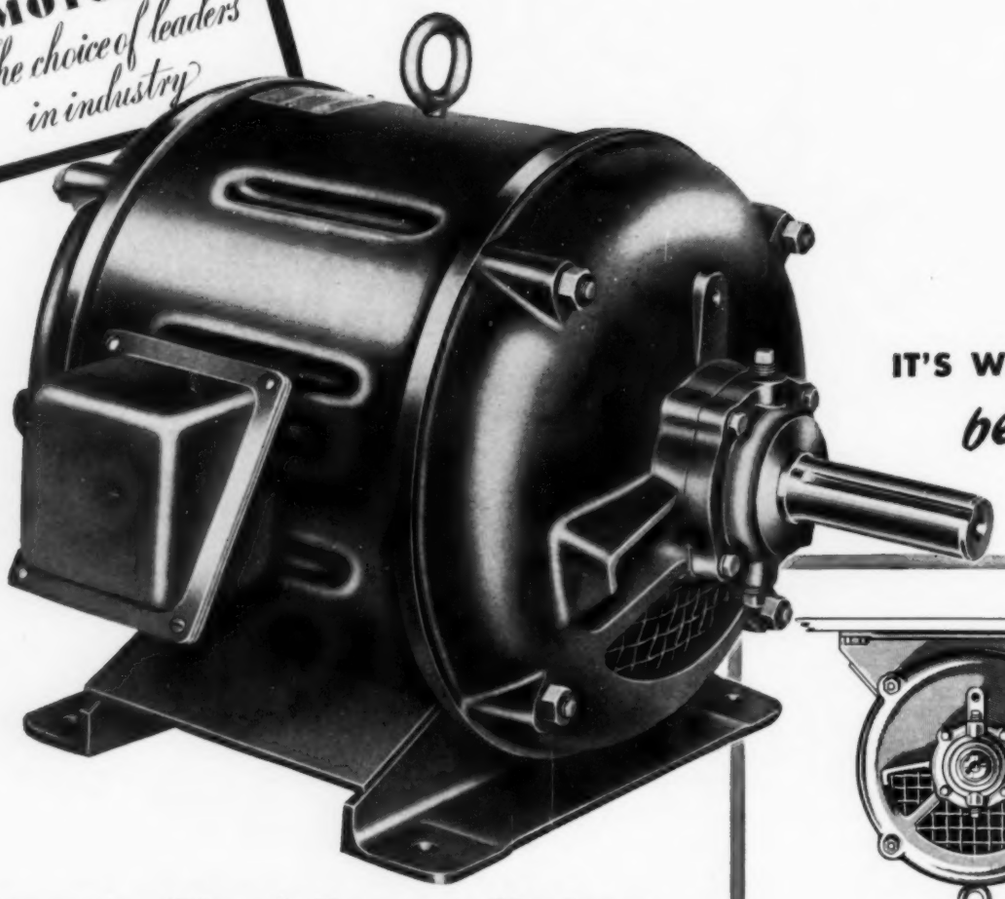

PLANT HIGH-VOLTAGE LINES
PACKAGE SUBSTATION FOR HOT-MILL AREA
PACKAGE SUBSTATION FOR COLD-MILL AREA
PACKAGE SUBSTATION FOR BLOOMING-MILL AREA

In high-voltage transmission, incoming utility or plant-generated power is transmitted at voltages of 33 kv or 69 kv to individual mill-load areas. Here it is stepped down at G-E Package Substations to utilization voltages, usually 6.9 or 13.8 kv.

GENERAL ELECTRIC

659-76

WAGNER MOTORS
...The choice of leaders in industry



IT'S WAGNER *because:*

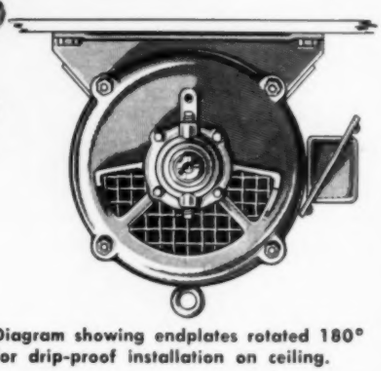


Diagram showing endplates rotated 180° for drip-proof installation on ceiling.

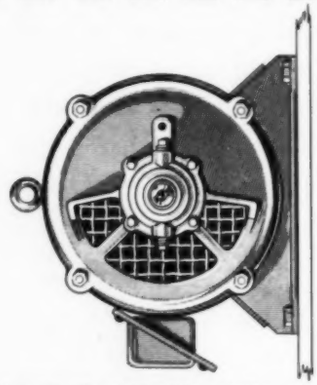


Diagram showing 90° rotation of endplates for drip-proof horizontal mounted sidewall installation.

Wagner Steel-Frame Motors proved by years of service!

Wagner steel-frame drip-proof polyphase motors have been proved—durable, dependable, and trouble-free—by twenty years of hard usage in industry after industry.

These open-type squirrel-cage motors are available through 326 frame size, with either sleeve or ball bearings. The motor frames are formed of heavy rolled steel, shaped to accurately center the stator core and to provide passages for adequate ventilation. A large auxiliary fan draws in air through the openings in the front endplate, forces it through these passages and out through the endplate openings on the drive end. Heat is effectively carried off from all parts of the motor. Because of the fact that there are no openings in the frame, these motors are completely drip-proof when mounted in the normal horizontal position, and by rotating the endplates are still drip-proof in the sidewall or ceiling horizontal positions.

Bulletins give full information on the complete line of Wagner Motors. Thirty-one branches, located in principal cities, are ready to assist you whenever you have a motor problem. In addition, almost 500 authorized motor repair shops provide speedy, nationwide service facilities.

Wagner Electric Corporation
EST. 1891

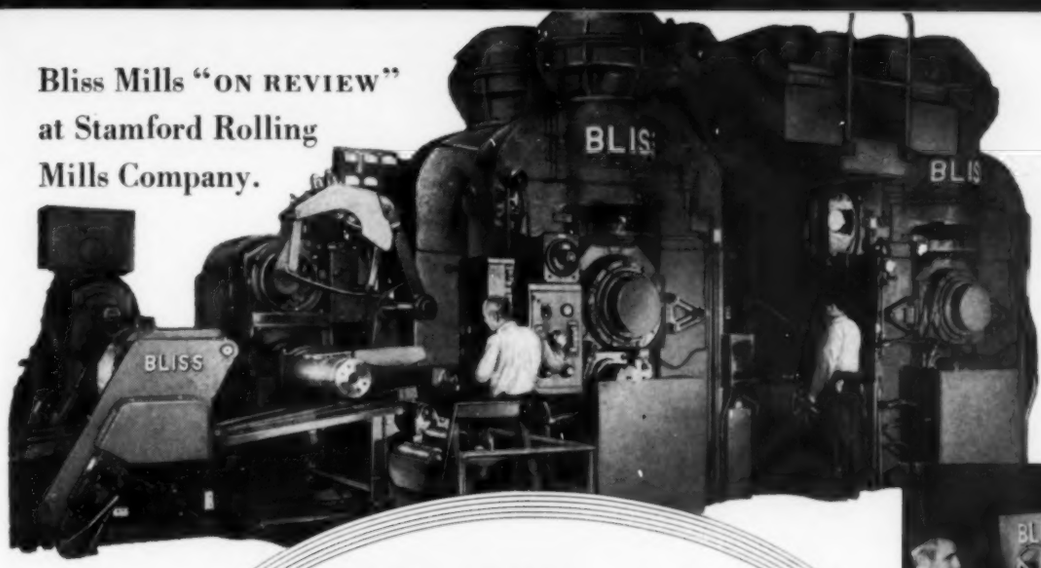
WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS – AIR AND HYDRAULIC

BRANCHES IN 31 PRINCIPAL CITIES

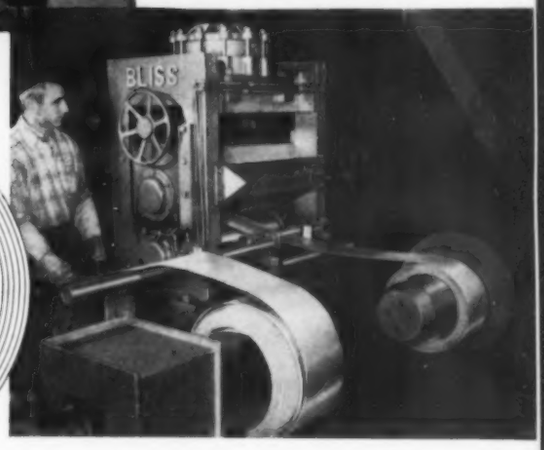
M10-30

Bliss Mills "ON REVIEW" at Stamford Rolling Mills Company.

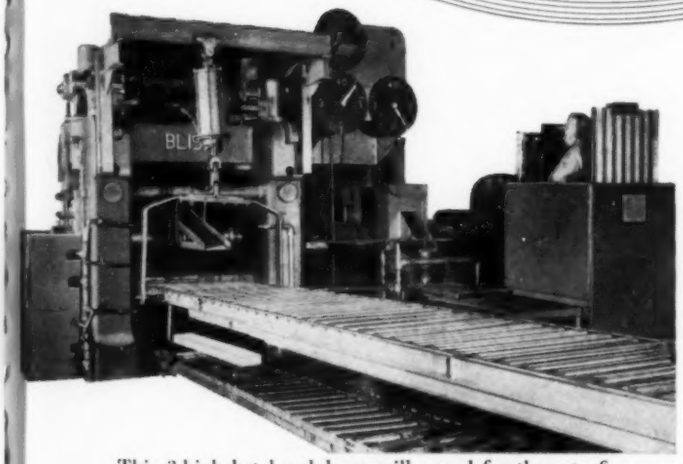


Brass and copper breakdown is the job of this Bliss 4-high, 2-stand Tandem Strip Mill. Bliss coiler, at far left, coils flat bars. Tension reel winds lighter-gauge coils.

Heavy-gauge coils and flat bars are easily handled by this Bliss pinch roll feed. Entry side auxiliaries are designed to handle either coil or flat-bar stock.

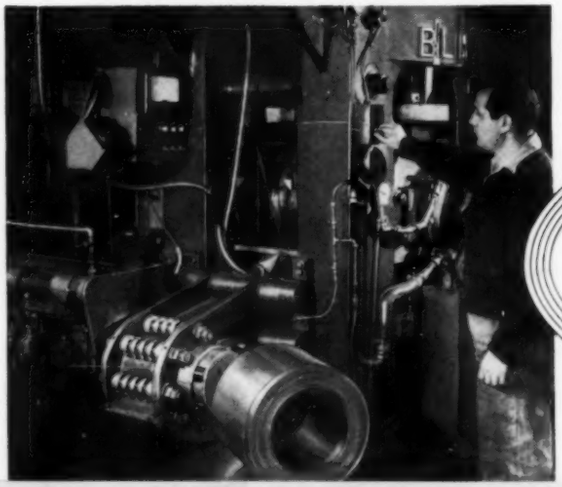


All different rolling jobs..... All different Bliss Mills



This 3-high hot breakdown mill—used for three to five pass work—is being equipped with Bliss mill tables to facilitate and speed manipulating of brass bars.

Brass stock is finish-rolled in Bliss 4-high finishing mill.



You'd expect to see a variety of mills kept busy where so many different alloys and gauges of quality copper and brass are rolled in such large quantities as at the Springdale, Conn., plant of STAMFORD ROLLING MILLS COMPANY.

Here is a model of integrated production efficiency whose rolling mill equipment is predominantly BLISS—a 3-high hot breakdown mill, a 4-high, 2-stand tandem strip mill, a cluster mill for rundown, and another 4-high mill doing most of the finish rolling. In addition, the copper mill is being revamped for Bliss equipment.

Almost every mill is also equipped with Bliss accessories. The tandem mill, used for breakdown of both bar and coil stock, uses a Bliss pinch roll feed with a Bliss coil mandrel and elevator for quick, easy opening and handling of heavy-gauge coils. Flat bars are coiled on a Bliss coiler, and a Bliss tension reel, with belt wrapper, winds lighter gauges into compact, easy-to-handle coils. This complete Bliss mill unit has been operating at from 700 to 800 fpm for two years, working 16 hours a day, five days a week.

All the work-saving features of Bliss rolling mills and accessories can fit your production scheme, whether you do hot or cold rolling of ferrous or non-ferrous metals. Our engineers will be glad to discuss your problem with you.

E. W. Bliss Co.

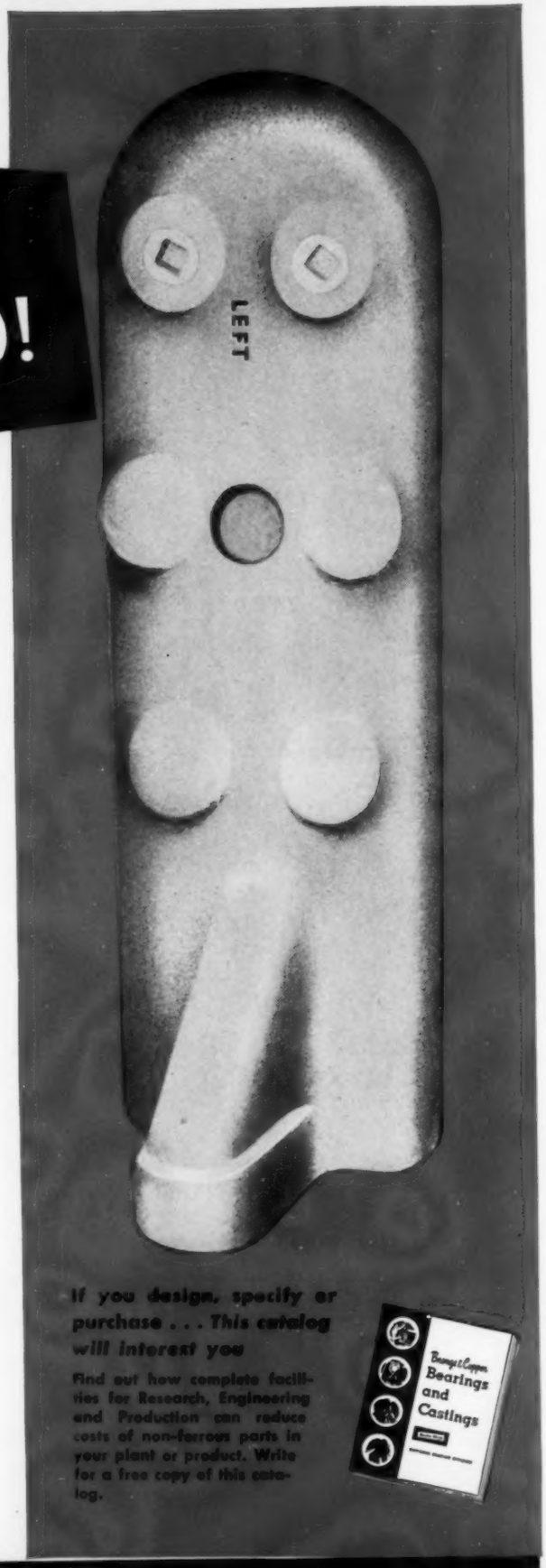
General Office: Toledo 7, Ohio

Rolling Mill Division

Salem, Ohio

Rolling Mills, Mechanical and Hydraulic Presses, Container Machinery

THIS CASTING SAVED $12,000.00!



Why an Electrode Holder, redesigned by National Bearing Division, lasted over 73 times longer

A large Midwest plant was getting 5 days service from furnace electrode holders . . . before a trial order was placed with National Bearing Division. This plant saved dollars—*right from the start.* A special copper alloy permitted sound, dense castings at no sacrifice in electrical conductivity. Result? *30 days service—instead of 5—before replacement.*

On the next order, National Bearing Division engineers submitted a new design for the clamp—for greater strength and resistance to cracking. The redesigned electrode holders are still in use—after a year of trouble-free operation! They've saved $12,000.00 on replacement costs and furnace maintenance.

Better, longer-lasting non-ferrous parts can save money in your plant or product . . .

National Bearing Division has complete facilities for finding practical, economical solutions to non-ferrous bearing and casting problems. Investigate these complete facilities—whether your problem requires designed engineering service, or production of non-ferrous parts to your own specifications.

If you design, specify or purchase . . . This catalog will interest you

Find out how complete facilities for Research, Engineering and Production can reduce costs of non-ferrous parts in your plant or product. Write for a free copy of this catalog.

NBM

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

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FREYN – DESIGN
modern
OPEN HEARTHS
include the know-how of
OPEN HEARTH COMBUSTION COMPANY

In the forefront through the years

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- THE SLOPING BACKWALL
- THE VENTURI PORT
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FOR DESIGN OR CONSTRUCTION, FOR FURNACES OR COMPLETE SHOPS

KOPPERS

METALLURGICAL PLANT DESIGN AND CONSTRUCTION

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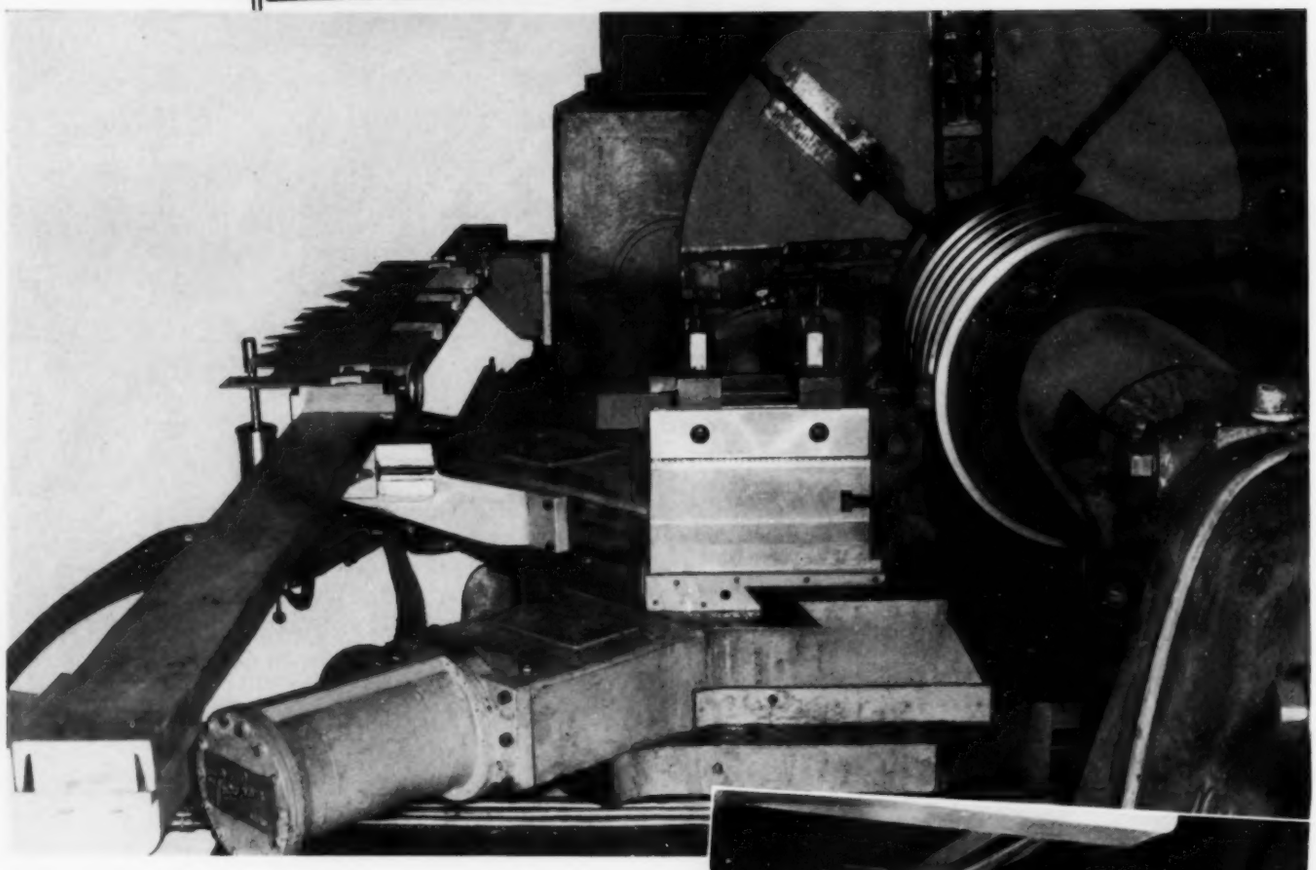
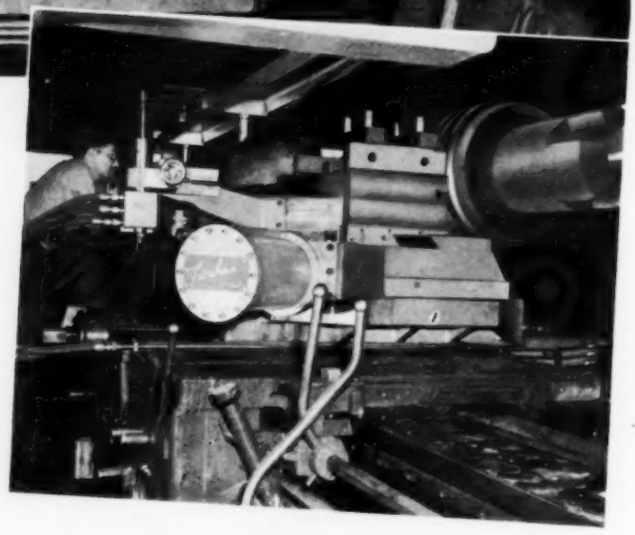
109 NORTH WABASH AVENUE · CHICAGO 2, U.S.A. Associated with Ashmore, Benson Pease & Co. Ltd., Stockton-on-Tees, ENGLAND; De Lattre & Freyssinet, Paris, FRANCE

ANOTHER TURCHAN FIRST!





Intricate mill roll turned in 36 hours, instead of 60 by hydraulic tracer control

Saving about half in time of machining this 24 inch roll on a giant 72 inch lathe is an achievement. The entire job is done to accuracies beyond human capacity. Turchan is definitely first to make possible a new combination of tool movements with the Turchan Dual Follower attachment for lathes, to handle any type or size work within the machine's capacity. A cross slide equipped with 2 compounds mounted at 45° to center line and 90° to each other, replaces the standard slide. This allows reproducing perfectly square shoulders, radii and bevels on right or left of center, or combinations of both, with the ease of flat work. Faster machining time, simplicity of setup, no need for costly form tools and elimination of hand-finishing, plus accuracy of .002 variation, are superior advantages. There are Turchan Follower attachments to convert any standard machine tool — lathes, shapers, planers, mills and grinders. **"Turn to Turchan to cut costs."**

WRITE US TODAY: Send us a sketch and specifications of any job. Give make of machine. We'll show you how to produce it better, faster, at lower cost.

Turchan

FOLLOWER MACHINE COMPANY

8259 LIVERNOIS AVENUE
DETROIT 4, MICH.

Oldest Manufacturer of Hydraulic Duplicating Attachments for Machine Tools

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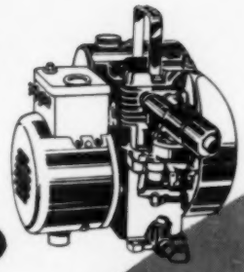

U. S. Pat. 2,181,076

HELPS MAINTAIN MAXIMUM LIGHT HERE

Speer carbon brushes are popular with the men who make and maintain portable generators—and rightly so! They know that long-lived Speer brushes are constructed to meet widely-fluctuating load demands and provide excellent commutation with relative freedom from oxidation.

Speer's complete line of carbon brushes is backed by more than 50 years of experience. As a result, Speer brushes offer outstanding performance regardless of load conditions . . . highest current-carrying capacities . . . freedom from overheating, sparking, and excessive wear and energy loss. Complete experimental and testing facilities are available for your design or maintenance problems.

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CARBON COMPANY
ST. MARYS, PENNA.

brushes • contacts • welding electrodes • graphite anodes • rheostat discs • packing rings • carbon parts

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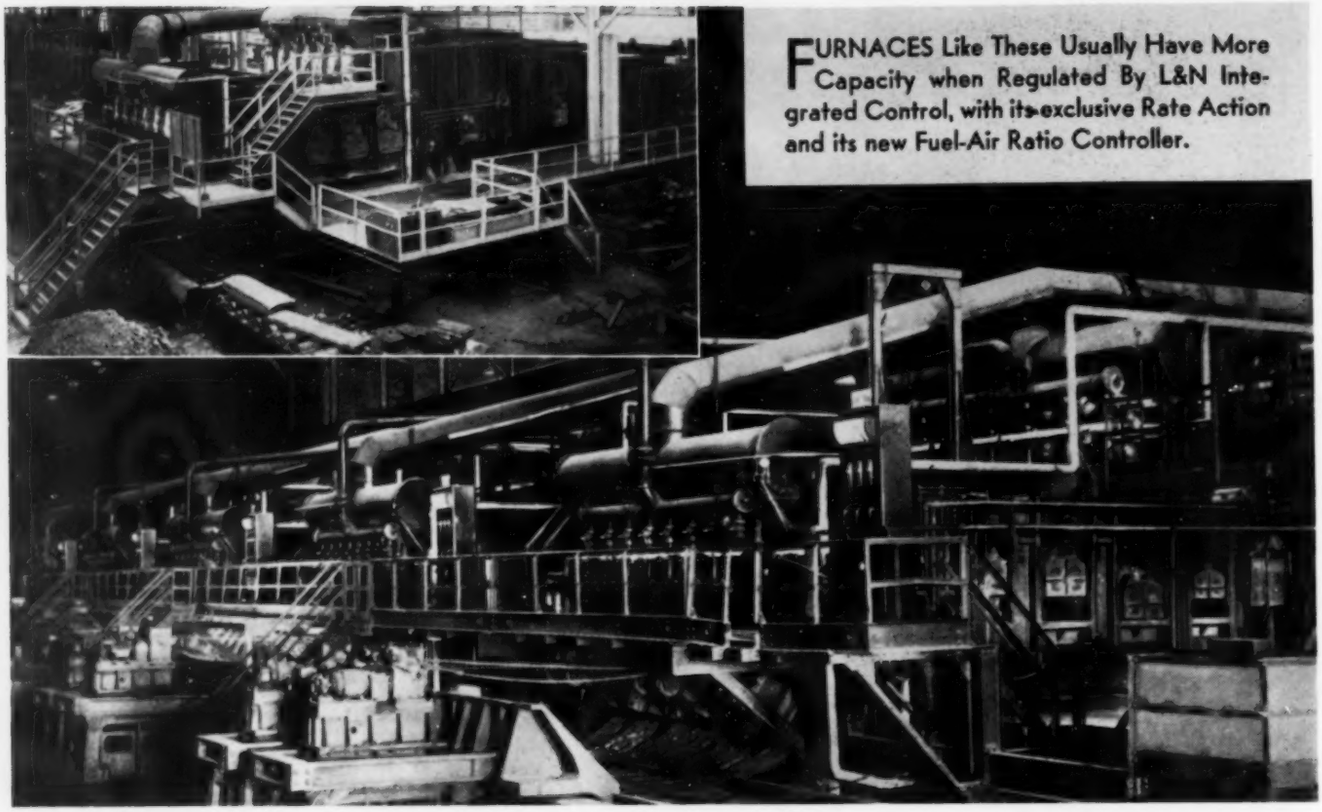


FURNACES Like These Usually Have More Capacity when Regulated By L&N Integrated Control, with its exclusive Rate Action and its new Fuel-Air Ratio Controller.

See Us Wrap Up Temperature, Draft and Combustion In One Integrated Control to Make More Steel

A PARTIAL MOCK-UP of a furnace like those above is in our booth at the Iron & Steel Engineers Show, Cleveland, September 26–29. You're invited to drop in, handle the control dial settings and watch the resulting changes in simulated furnace conditions. You can thus judge for yourself whether Integrated Control can help to increase production in your plant. Present users say it lets their men set the instruments so that variations in either temperature or draft or combustion — or any two conditions — are automatically corrected without upsetting the furnace operation. To you, it may spell more production of anything you're heating; whether ingots, slabs, billets, formed parts or assemblies.

You'll Want to Know About P.A.T.'50

One of the most important features of Integrated Control is our P.A.T. '50 equipment, which handles the temperature part of Integrated Control with a speed that's entirely new.

Externally, the P.A.T. '50 looks almost exactly like earlier L&N Position Adjusting Type Control equipments. But there's a vast difference in action. Previous controls take care of temperature swings caused by (1) the *size* and (2) the *duration* of temperature changes. To these, P.A.T. '50 adds correction for (3) the *speed* or rate of such changes.

This Rate Action, as it's called, is a brand-new way of bringing a furnace back to optimum temperature *faster* than it can be restored by any other control device! And it's not only brand-new with P.A.T.; it's a brand-new L&N first in the field of electrically-driven positioning control.

The Fuel-Air Ratio Controller in Integrated Control is also new. It gives your organization L&N quality throughout its Integrated Control System. All instruments are of the same family, designed in sensitivity and accuracy to work with each other for best possible production.

We will also be ready, at the Iron & Steel Show, to talk about measuring the temperature of open-hearth baths by Thermocouples as well as by Immersion Rayotubes or Optical Pyrometers. This couple is brand-new; and only L&N can give your organization a choice of all three methods.

Don't Forget — See L&N at Booth 100 at the Iron & Steel Engineers Show!

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Jrl Ad N-0661(1)

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

HERE'S WHY THE TYPE M STANDS OUT OVER ALL OTHERS

UNIT CONSTRUCTION. All parts assembled on one frame are completely accessible from front. Alignment is independent of accuracy of panel drilling . . . only three mounting holes required.

KNIFE-EDGE BEARING. No hinge pins to wear or corrode. Knife-edge fulcrum of special hardened steel forms simple, friction-free bearing.

UNIT MOUNTED INTERLOCKS. Mounted directly on contactor frame . . . maintain correct alignment with moving armature.

QWIK-QUENCH ARC BOX. Double-pocket design provides faster arc interruptions and longer contact life.

Nothing Newer ...Nothing Better

This all-new line of Type M Heavy-Duty D-C Contactors is announced now after 9 years' actual trial service on the toughest jobs in industry. It's backed by 40 years of user experience in building steel mill controls.

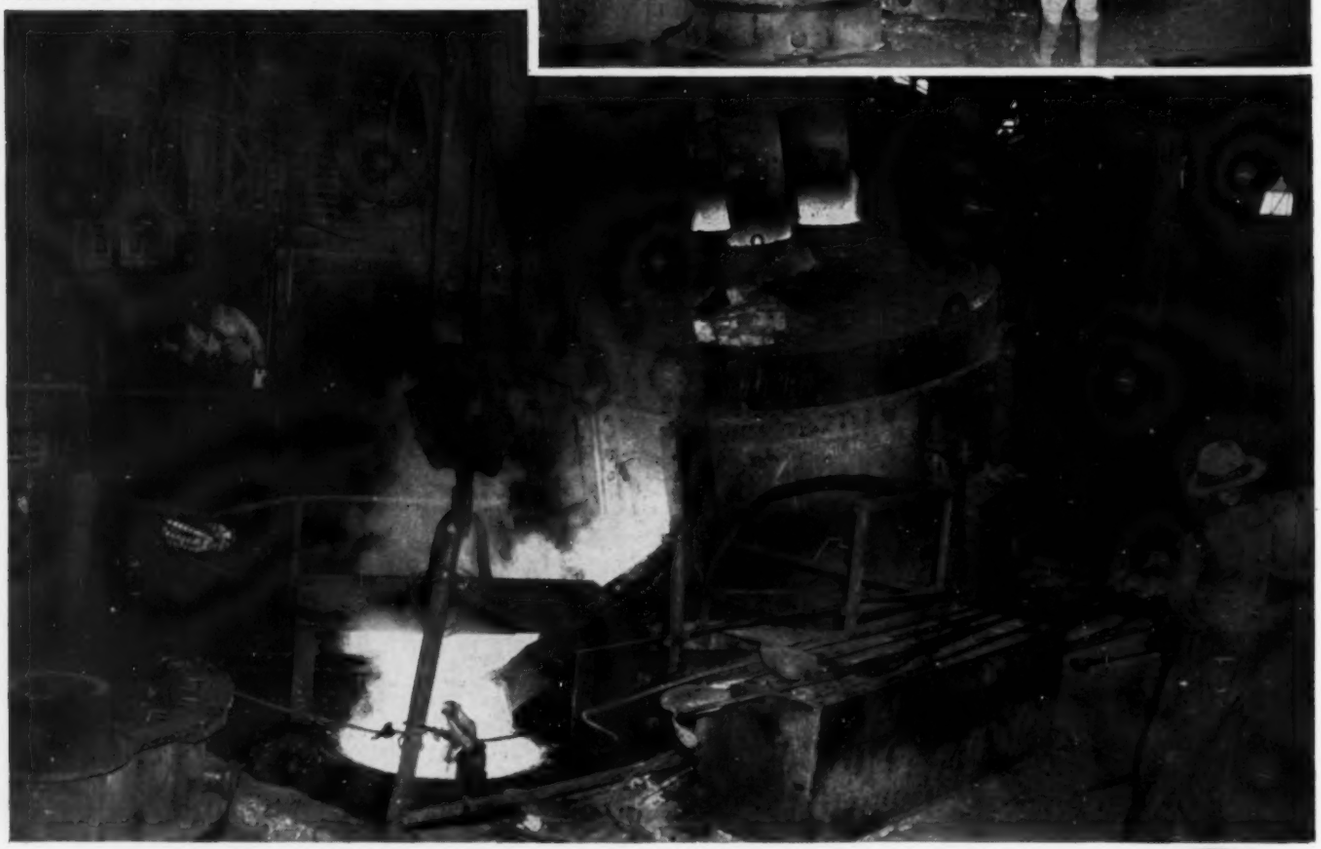
Want more details? Your Westinghouse representative has them. Ask him for a copy of B-5261. Or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-27000

See it work . . .
See its features

at the Iron and Steel Show, Cleveland, Sept. 26-29, 1950, Booth 201.

Westinghouse
STEEL MILL
MOTORS AND CONTROLS



NE

Symbol of Highest Quality

To users of industrial gears and castings NE offers complete control from raw materials to finished product—modern foundry facilities both open hearth and electric, permit prompt attention to your requirements. Consult with us. Ask for bulletin No. 7.

MEMBER OF AGMA

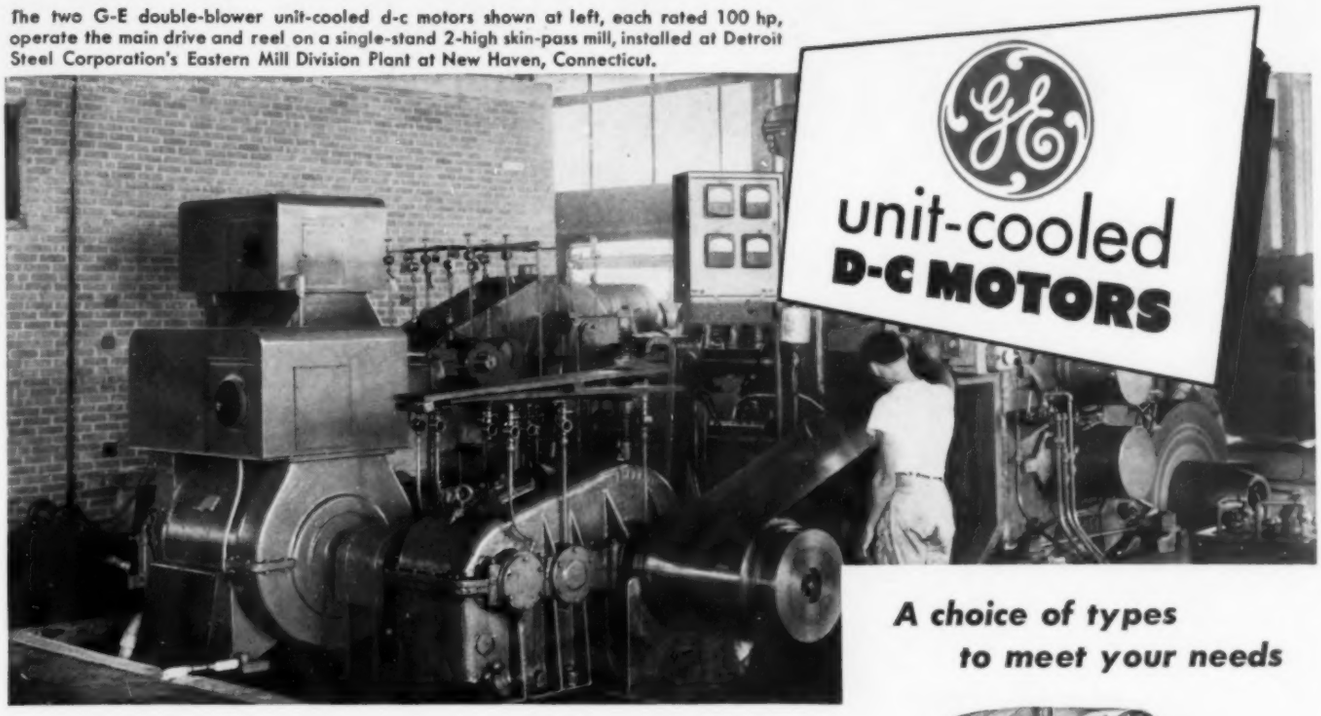
NATIONAL ERIE CORPORATION

ERIE, PENNSYLVANIA • U. S. A.

MEMBER OF SAE

NE

The two G-E double-blower unit-cooled d-c motors shown at left, each rated 100 hp, operate the main drive and reel on a single-stand 2-high skin-pass mill, installed at Detroit Steel Corporation's Eastern Mill Division Plant at New Haven, Connecticut.



self-protected...to cut installation costs!

In dusty, dirty or oil-laden atmospheres—where open motors can't take it without special protection—you can cut installation time and costs to a minimum with General Electric totally-enclosed unit-cooled d-c motors. Motor and unit cooler, completely factory-assembled as a unit, come to you ready to install. They need no specially-built motor room, no piping, ductwork, coolant, filters or pressurized air supply. You simplify plant layout, save extra equipment cost!

These better-protected, better-cooled G-E motors—available in ratings from 15 to 200 hp—also

. . . **minimize inspection shutdowns!** Windings, brushes and brush rigging are kept clean at all times because harmful air-borne materials can't get into the motor's internal ventilating air.

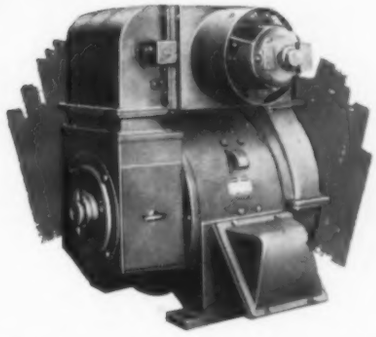
. . . **reduce power cost!** Because motor heat is rapidly dissipated, power consumption is less, especially in wide-range adjustable-speed motors.

. . . **simplify maintenance!** Large openings in the commutator end shield make it easy to get at commutator, brushes, and brush rigging.

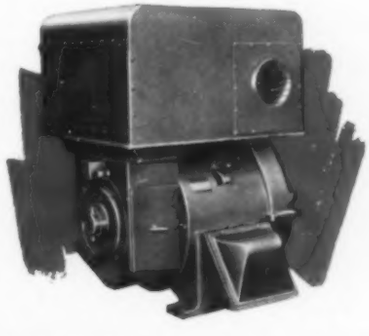
. . . **save mounting time!** Interchanging of motors to meet changing mill conditions takes less time because G-E totally-enclosed motors have the same mounting dimensions as G-E open motors of the same ratings.

Get the whole story! Ask your G-E representative how these sturdy, protected motors can help trim operating costs in *your* mill, or send for Bulletin GEA-4469. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

A choice of types to meet your needs



In single-blower type— for constant and adjustable speed operation at normal speed—unit cooler circulates internal air with a shaft-driven fan. External air is forced through alternate air passages by a separate motor-driven blower.



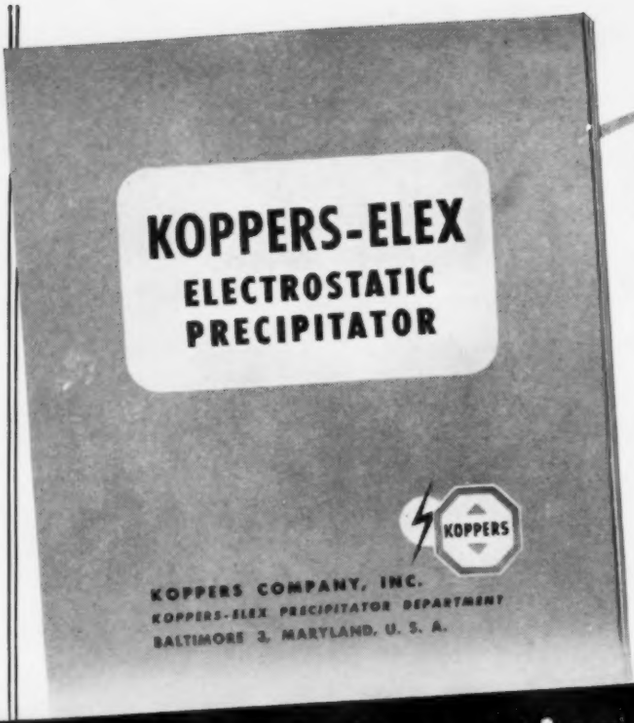
New double-blower type— can be operated continuously without harmful overheating, even at very low speeds. A single Tri-Clad® auxiliary induction motor drives both blowers, one for internal motor air, the other for external cooling air.

GENERAL ELECTRIC

770-18

Booklet Describes How . . .

One factory specified 97% efficiency, but actually gets over 99% efficiency!



SEND FOR THIS VALUABLE FREE FOLDER!

Gives vital information on how to make recovery, gas cleaning and nuisance abatement pay off!

Improved power units save money on installation cost.

•

Sequential rapping provides uniform stock discharge.

•

Insulators, protected from gas stream, require minimum maintenance and replacement!

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High efficiencies are obtained around-the-clock for a full 24 hours a day!

•

New engineering on certain industrial gas applications enables recovery to pay up to 75% annual dividend on original cost!

•

Koppers-Elex provides for lowest possible pressure loss.

•

You can get both specified efficiency and residual content left in gas unconditionally guaranteed!

● No matter if your plant now uses precipitators, or plans to install one in the future—send for this timely folder! It's packed with performance and engineering data. Gives facts on maximum efficiency, shows how recovery, nuisance abatement or gas cleaning can PAY OFF!

Your copy contains illustrations, design information, facts about proper rapping, collecting and maintenance—all vital information collected by the Koppers Company in more than 60 years' manufacture of high-efficiency gas cleaning equipment.

To get your free copy, just fill out and mail the coupon below. There is no obligation. Check which field interests you most and mail coupon to the Koppers Co., Inc., Koppers-Elex Precipitator Dept., 260 Scott St., Baltimore 3, Maryland. We have only 1000 copies on hand, so to make sure you get yours—please mail the coupon today.

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Gentlemen: Please send me your free booklet. I understand there is no obligation.

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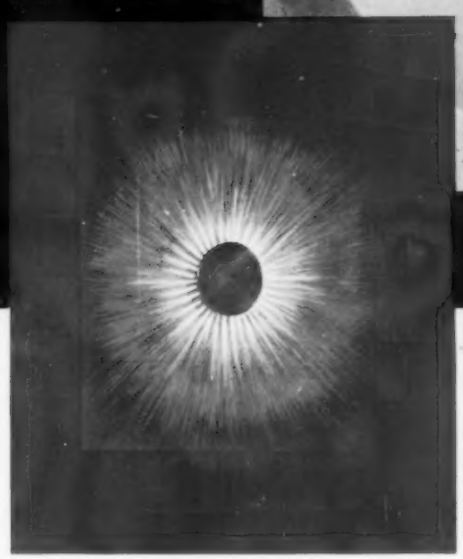
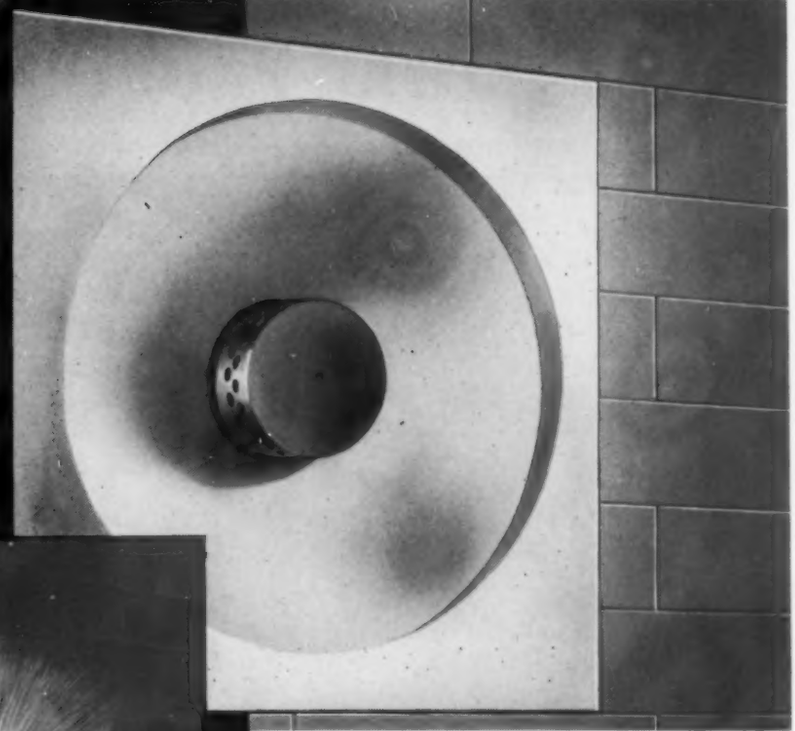
CITY.....ZONE.....STATE.....

Please check which field interests you most:

☐ Recovery ☐ Nuisance Abatement ☐ Gas Cleaning

For precision heating with intense transfer of heat...





the Bloom

HTR

HIGH THERMAL RELEASE

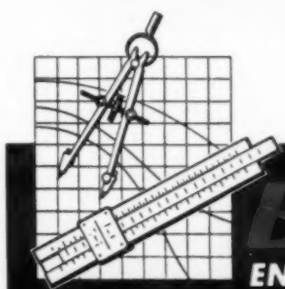
BURNER

Recommended for use where quick heating and intense concentration of heat are desired, the Bloom High Thermal Release Burner will release up to 750,000 Btu per cubic foot of combustion volume.

In this nozzle-mix burner, fuel (oil or gas) and combustion air are premixed within the alloy nozzle, forming a uniform, combustible mixture when discharged into the furnace. A turndown ratio of greater than 10 to 1 enables low input for holding purposes.

With this burner, experience has shown that thin sheets can be heated without scale, and forgings can be heated with little or no scale, in a fraction of the time ordinarily required.

Write for bulletin giving full details and description of the Bloom HTR Burner.



BLOOM ENGINEERING CO., INC.

857 W. North Avenue Pittsburgh 33, Pa.

PLANT POWER-PROBLEM:

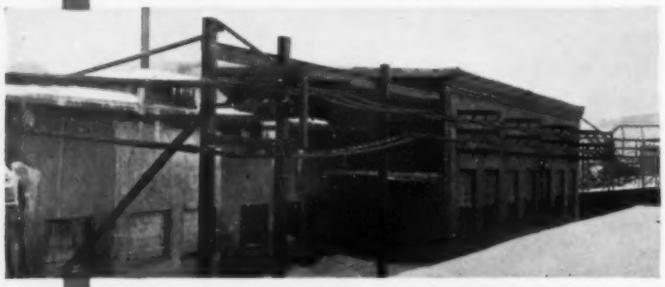
Costly outages caused by phase-to-phase flashovers and burndowns in open wiring strung in chemical atmosphere

SOLUTION:

OKOLITE-OKOPRENE

SELF-SUPPORTING AERIAL CABLE

COMPACT AND ECONOMICAL—Self-evident space economy combines with reasonable installation and low maintenance costs. 3/C #4/0 Okolite-Okoprene Self-Supporting Cables supply lighting for the various buildings.



DURABLE AND DEPENDABLE—Permanently weather-proof with no ring-cutting or lead sheath troubles. Long-lived, trouble-free circuits assured. 3/C, 500,000 CM Okolite-Okoprene 5 Kv Cables distribute power from sub-station to sulfite mill, beater room and screen room.

Dust, moisture and acid fog prevalent in the atmosphere surrounding the Rumford, Maine, mill of the Oxford Paper Company posed a problem in power circuit maintenance. The combination of these elements made it practically impossible to keep even the over-voltage insulators and wooden structures from becoming conducting to the point where even 2,300 volts resulted in phase-to-phase flashovers and burndowns. Moreover, burndowns of upper circuits would often cause loss of lower circuits through repeated burnouts as top wires dropped to underlying layers.

Solution of this serious problem was found in the substitution of Okolite-Okoprene Self-Supporting Aerial Cable for open wires. According to company officials, the combination of Okolite high voltage moisture and heat resisting insulation protected by non-conducting weather and chemical resistant Okoprene sheathing has eliminated this trouble.

With greatly reduced service interruptions and outages, Oxford engineers anticipate substantial reductions in maintenance costs. Other industrial users have had similar experiences and point out that this type of Okonite-engineered cable also gives improved circuit regulation because of lower reactance. In addition to its *dependability*, they value it for *compactness*—to eliminate congestion, reduce clearance problems, afford a modern, streamlined appearance—and for *economy*...to save on installation as well as maintenance costs.

For outdoor or indoor installations, the industrial applications of Okolite-Okoprene Self-Supporting Aerial Cables offer convincing advantages. These are fully described in a 52-page manual available to electrical engineers and company executives. For your copy, send a request on your letterhead to The Okonite Company, Passaic, N. J.

THE BEST CABLE IS YOUR BEST POLICY

OKONITE OKONITE SINCE 1878 ***insulated wires and cables***

Low Cost Production with

Wide Strip Annealing Furnaces

Increased tonnage with production economy . . . that's the actual experience reported by a leading steel company, operating Drever continuous annealing lines for 42-inch coiled silicon steel strip, pictured above.

Users report consistent, uniform anneal and excellent surface characteristics; resulting in increased stamping die life.

Cleaning is incorporated in the line, thus eliminating a separate operation.

Both quality and low cost production are designed, engineered and built into Drever Wide Strip Annealing Furnaces.

Complete annealing lines for Low Carbon, Tin Plate and Galvanizing stock; also Non-Ferrous strip. Capacities up to, or even exceeding 60,000 lbs. per hour.

View of two 20,000 lb. per hour DREVER CONTINUOUS ANNEALING LINES for 42" wide STEEL STRIP. Delivery end, showing 1820 K. W. Vertical Strip Furnaces and strip recoiling equipment.

P.S.

Our many years of experience is available to you, without obligation, in discussing your particular requirements.

DREVER CO.

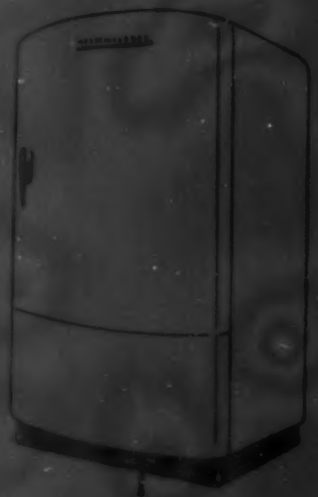
760 E. VENANGO ST., PHILA. 34, PENNA.

CONTINUOUS FURNACE LINES, HEAT TREATING FURNACES, DESCALING & ATMOSPHERE EQUIPMENT

W. PENNA., W. N. Y. and OHIO—H. C. BOSTWICK, 2277 KENMORE RD., CLEVELAND 22, OHIO
IOWA, MINN. & WIS.—WALTER G. BARSTOW, 1202 FIFTH AVE. SOUTH, MINN. 4, MINN.

Shaping Metal for all Industry

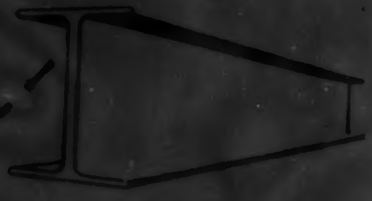
Ohio Rolls

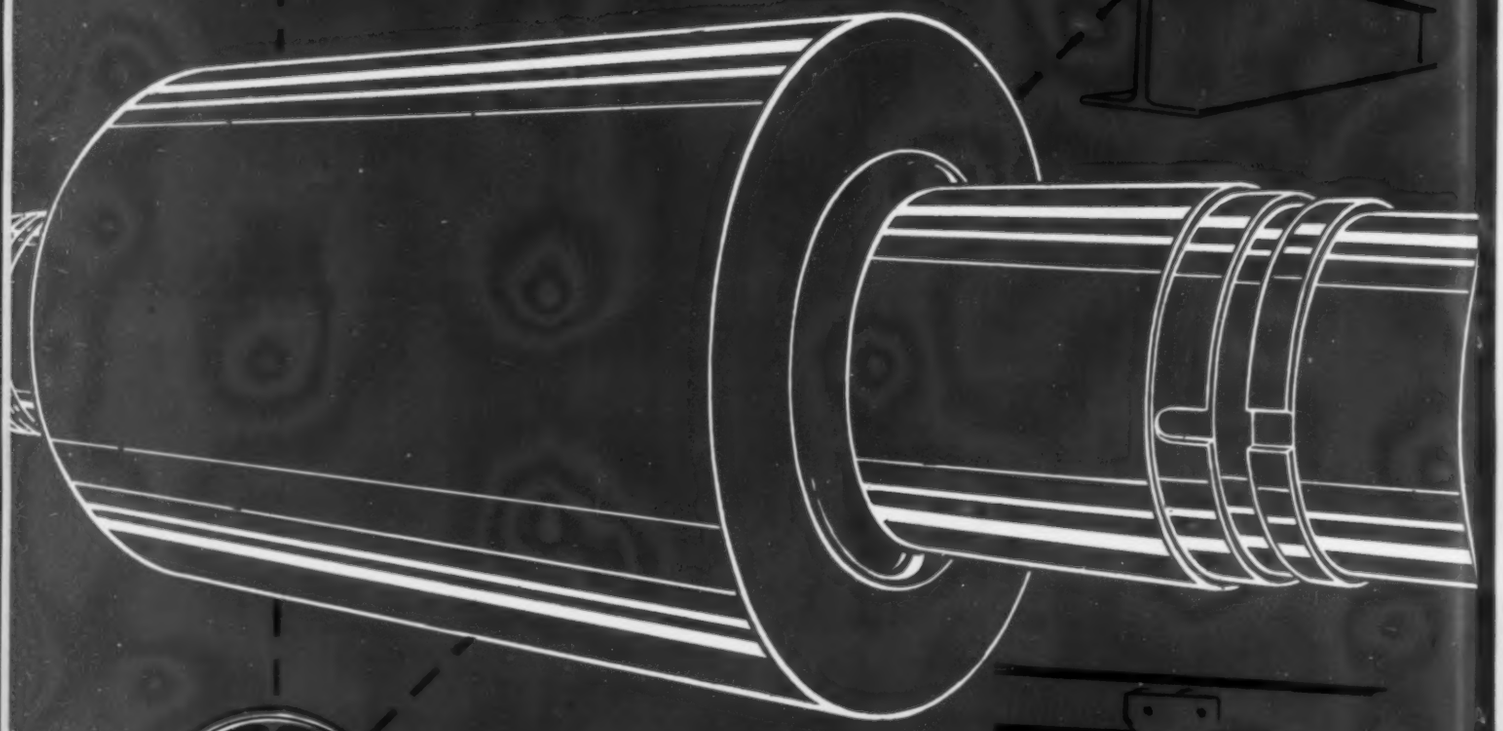


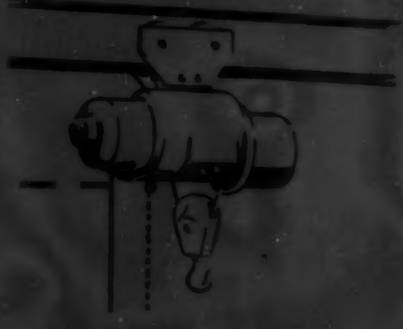
Select from any of these eleven types of Ohio Steel and Iron Rolls:

Carbon Steel Rolls	Dense Iron Rolls
Ohioloy Rolls	Nickel Grain Rolls
Ohioloy "K" Rolls	Special Iron Rolls
Roll-O-Cast Rolls	Nioloy Rolls
Chilled Iron Rolls	Flintuff Rolls

Alloy Chilled Iron Rolls







THE OHIO STEEL FOUNDRY COMPANY

LIMA, OHIO • Plants at Lima and Springfield, Ohio

Crops and Shorts

PHILIP MURRAY, president of the CIO United Steel Workers, recently visited Weirton, W. Va., to aid his union's attempt to sign up employees of Weirton Steel Co. Speaking to an audience of 78, of which 15 were Weirton employees, Murray said: "I say to you . . . that the people of Weirton are going to be organized . . ." Meanwhile, the new Independent Steel Workers union has signed up approximately three-quarters of the Weirton employees.

Officials of the CIO — USW profess disbelief that Weirton men prefer an independent union, and they claim that employees want the CIO union. In the past, however, the CIO union has always stymied requests for elections made by the old Weirton Independent Union, now dissolved by court order.

A review of the record shows the basis for Weirton employees' and Weirton towns people's preference. With their independent union, Weirton employees have obtained more liberal wage raises and more liberal pension and insurance benefits than have the CIO—USW unions in other plants. Furthermore, during Weirton's 17 years of experience with unaffiliated unions, there has never been an interruption of production or employment because of labor-management disputes. In other words, Weirton employees are considerably ahead of the game. Is it hard, then, to understand their preference for an independent union? Or to understand the towns people's desire that the employees have the right to express their preference?

▲

WRITING in Advertising Agency recently, Howard W. Newton said: "A lot of people are inclined to treat public relations as poor relations. The only connection between the two is that, if you neglect the former, you may become the latter."

▲

QUITE a few experienced engineers and industrialists who have been traveling recently in Europe feel that most of the European countries can now stand on their own feet without ECA funds. These individuals believe much ECA money is being used for purposes of temporary comfort rather than for permanent, long-range economic betterment. They observed much waste and what seemed to be a high cost of administration.

▲

SPEAKING before the St. Louis Chamber of Commerce, Warren Whitney told them: "Lenin of Russia was no fool. He once said 'Germany will arm itself out of existence; the British Empire will expand itself out of existence; and the United States will lend itself out of existence'."

▲

AS WE look out of our office windows each day, the lower end of Pittsburgh's triangle more and more resembles a heavily bombed area. There is wholesale wrecking of buildings good and bad, willy-nilly. Part of the cleared area is to be devoted to park purposes, and we know that governments have the right of eminent domain whereby they may condemn and purchase private property for public use. Another part, however, is to be used for a commercial venture by a big insurance company, who will build several office buildings. Included in this part were a number of buildings whose owners were forced to sell against their will, and these are the disturbing cases. We like to think that a man's house is his castle, not to be taken from him for private use by others.

▲

"WHEN I was a boy it was considered not only safe but honorable to create an estate, so that almost all men of standing wished to add to their possessions, and felt a certain dignified honor in prospering. But now one must apologize for any success in business as if it were utter violation of the moral law, so that today it is worse to seem to prosper than to be an open criminal."

You've often heard something like this in the past few years, and may have said it yourself. But who said it first? We can't say for sure, but an old Greek named Isocrates said it some 2300 years ago.

▲

YOU hear a lot about the waste of valuable knowledge and experience through compulsory retirement of men at age 65. No one, however, is worrying about the waste of those peak years of mental activity between 4 and 18 years of age. At 4, we know all the questions and at 18, all the answers.

▲

SOME African tribes insist that a man must kill a rhinoceros before he is qualified to hold office. In the United States it is only necessary to shoot the bull.

▲

A CORRESPONDENT tells us that, as he drives along the highways, he always reads those continued signs strung along the road advertising shaving cream, but never realized that the highway department used the same story-telling technique with their signs until he passed the following sequence: Soft Shoulders — Dangerous Curves — Men Working — Children Playing.

▲

THE last week of this month will find the 1950 AISE Convention and Iron and Steel Exposition in Cleveland, bigger and better than ever. The Exposition will be the largest in Association history, while the technical program has been enlarged and broadened over previous years. Both will contain hundreds of ideas that will help to increase production and improve operating efficiency. See you in Cleveland, September 26, 27, 28 and 29.

...high carrying capacity

...like INTERNATIONAL GRAPHITE ELECTRODES

International GRAPHITE AND ELECTRODE CORP.
ST. MARYS, PA.

IF IT HAD BEEN SCIENTIFICALLY HEAT PROCESSED.

SELAS **Gradiation** MAKES

HEAT A PRECISION TOOL FOR ALL INDUSTRIES

Pipelines are built to cut costs, but costs can be cut before the pipelines are built . . . with scientific heat processing. As much as a million dollars may have been saved on the "Big Inch" if the pipe had been heat processed by Selas Gradiation.

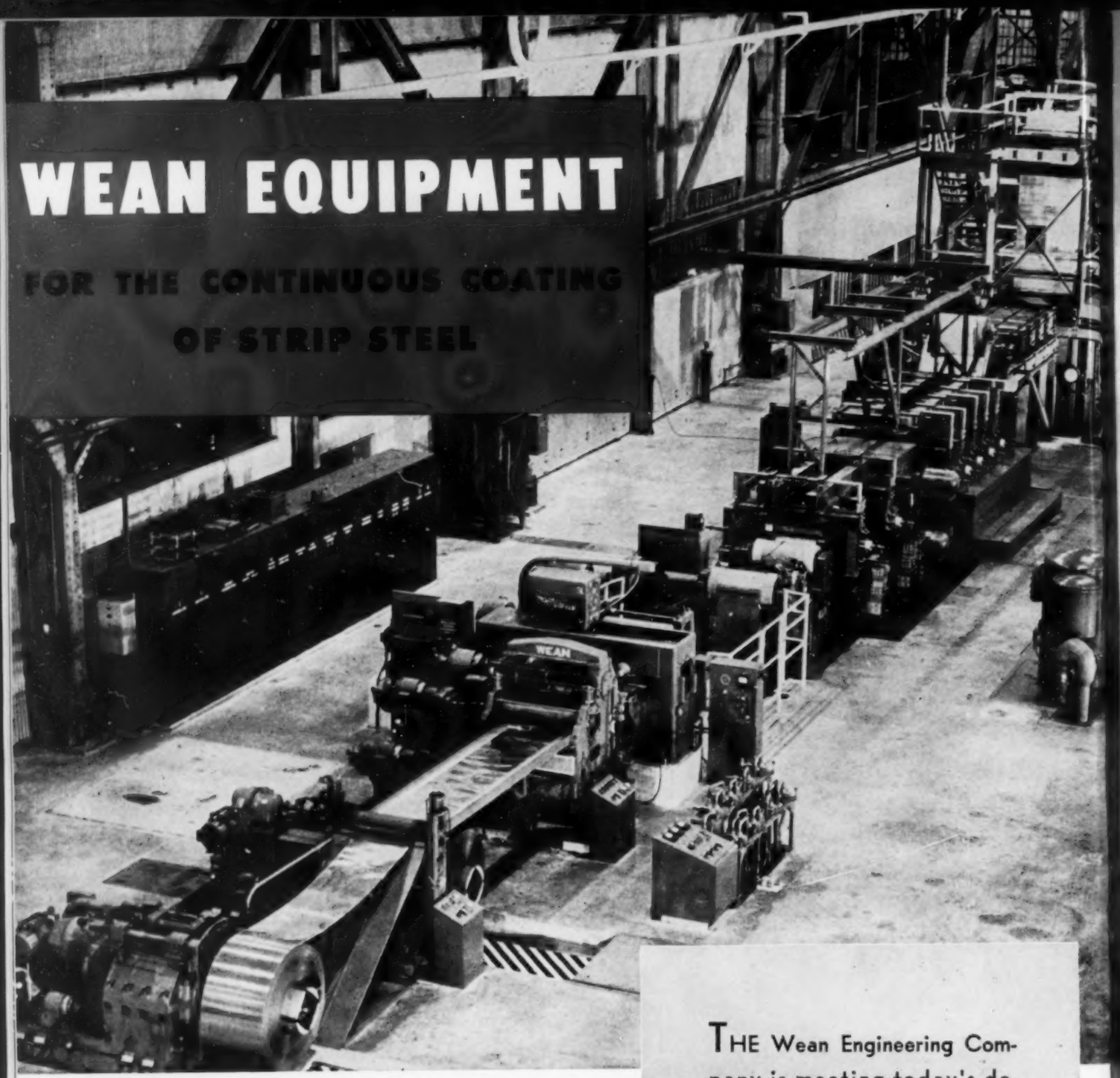
In the first continuous seamless steel tube mill, processing 2⅝" to 9¼" O.D. steel tube at National Tube Corporation (USS), heating speeds up to 240 feet per minute were achieved . . . 40 tons per hour. Heating was accomplished in seconds with a continuous flow of tubing instead of batches that previously required hours.

Gradiation, with its precision radiant heat, has proved its value in better quality and increased production of metals in annealing, hardening, drawing, forging, bending, or reheating. Wherever heating is used in working with metals, Selas Gradiation has improved methods and product quality . . . established new high production rates.

Selas Engineering makes heat serve the metal industry as a precision tool for faster, better and less costly production. If you use heat in processing, you can use the new developments of Selas Gradiation . . . and you will be interested in our many technical booklets on heat processing metals.

HEAT PROCESSING ENGINEERS FOR INDUSTRY . . . DESIGN, DEVELOPMENT, MANUFACTURERS

SELAS CORPORATION OF AMERICA
PHILADELPHIA 34 PA



WEAN EQUIPMENT

FOR THE CONTINUOUS COATING OF STRIP STEEL

THE Wean Engineering Company is meeting today's demands for equipment to produce tin plate and zinc coated strip steel with light coatings by the electrolytic method; also equipment to produce chemically treated black plate and strip steel. Equipment for coating strip steel with zinc and other materials by the hot dip method is also available.

The WEAN ENGINEERING COMPANY, Inc.

WARREN ---------- OHIO

Associate Company—Wean Equipment Corp.—Cleveland, Ohio

SPECIALISTS IN SHEET, TIN AND STRIP MILL EQUIPMENT

Iron AND Steel ENGINEER

SEPTEMBER, 1950 VOLUME XXVII NUMBER IX

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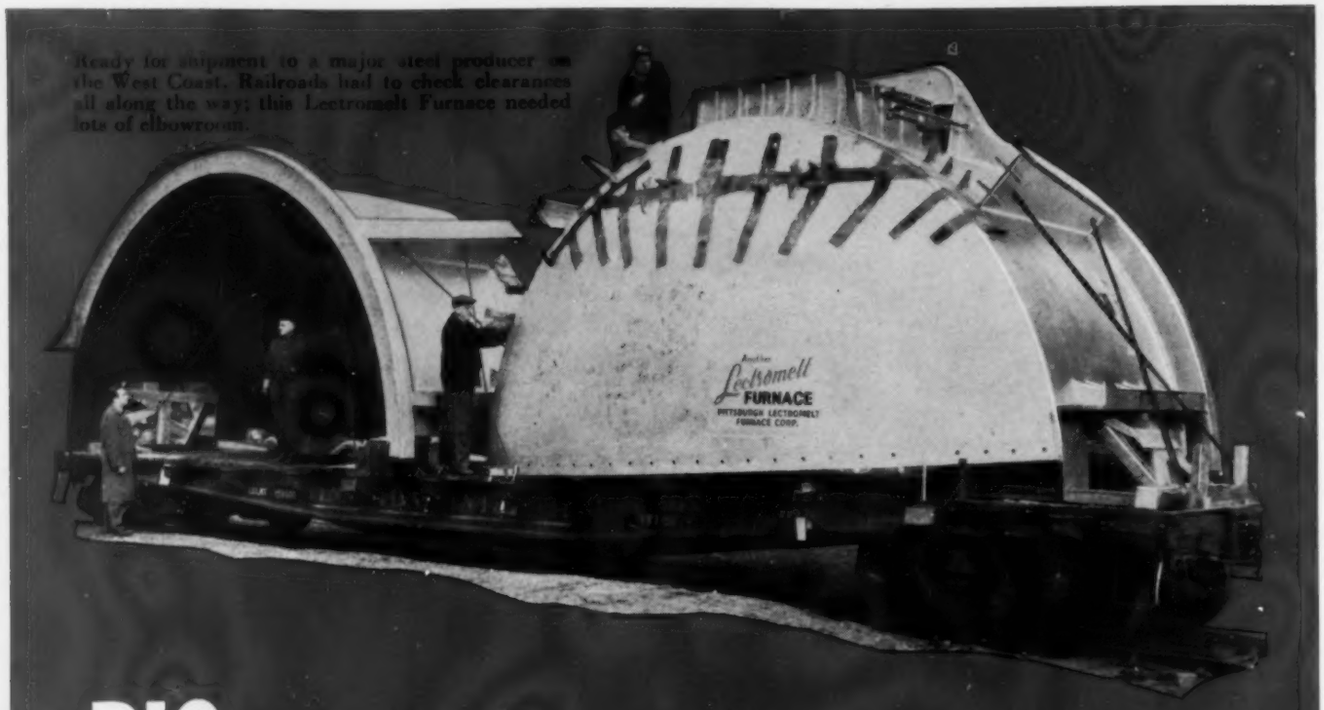
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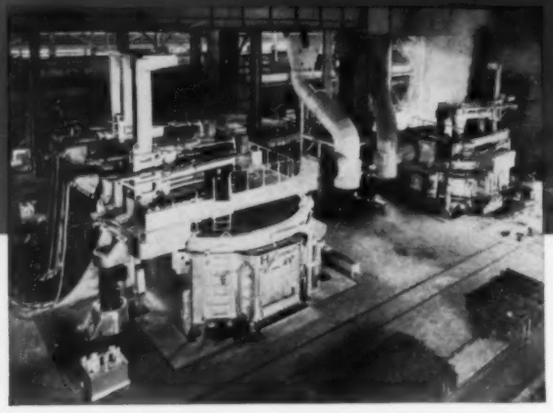

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WHEN YOU MELT... MOORE RAPID *Lectromelt*

Washouts of High Pressure Steam Turbines

By W. K. DUMBAUGH
Superintendent of Power Plants
Weirton Steel Co.
Weirton, W. Va.

. . . . increased availability of turbines is accomplished by the washout procedure described here . . . .

▲ CONTINUED carryover from steam boilers creates a deposit formation in the steam passages reducing the efficiency and capacity of a great portion of operating turbines today.

Various types of deposit are found on turbines dependent on the type of feedwater treatment and load conditions. Turbine blade deposits consist of soluble and insoluble material, and when it is soluble, it can be removed by turbine washing with initially wet steam. This paper, being written solely from a practical standpoint, no attempt is made to enter into technicalities of chemistry of water treatment, however, the water treatment in our plant being lime-soda, our deposits to date have all been water soluble made up primarily of sodium hydroxide and sodium chloride with a smaller percentage of sodium sulphate and sodium silicate according to chemical analysis.

In the plant of the Weirton Steel Co. today, there are three high pressure turbines in operation, namely, two topping turbines operating on 800 psi pressure at 800 F total temperature steam, discharging into a low pressure steam header line at 225 psi pressure with 540 F total temperature, driving alternating current generators at 3600 rpm, rated 10,000 kw at 80 per cent power factor and one turbine operating on 800 psi, 800 F total temperature steam exhausting to a vacuum and driving a 25,000 kw, 80 per cent power factor alternating current generator at 3600 rpm.

The first of these units installed was the No. 6 topping turbine in June of 1936. At the time of this installation, turbine washing was practically unheard of with no recommendations by the manufacturers. Over a period of operating time following the installation of this unit, it was noted that the output was gradually decreasing. From changes in pressures observed throughout the unit, it was evident that deposit was forming on the buckets decreasing the available capacity and efficiency of the turbine. Being faced with several days outage required to dismantle the machine for cleaning, various methods of washing were considered and tried out over a period of time. The first washout was made on February 28, 1937. During the ensuing years, experiments were continued until the present day method was attained for the first time on a washout of the No. 6 topping turbine May 30, 1943. Previous to this washout, the operating hours between washing periods ranged from 1400 to 1700 while present day periods on this same unit vary from 4400 to 4600 operating hours with results as shown in the following washout information picked at random and self explanatory given in Table I.

Table II gives compiled information in connection with availabilities and is self explanatory:

The No. 7 topping turbine does not require as frequent washing due to a designed second reaction stage by-pass valve, which makes possible the admission of high pressure, high temperature steam to the exhaust end of the turbine. This valve is operated on each eight hour turn under heavy load conditions, and in our belief tends to crack the deposit formation and clean the exhaust end blading, the deposit formation in topping turbines being at this point.

Table III gives washout information picked at random.

The information on availability of the No. 7 topping turbo-generator is given in Table IV.

Figure 1 — Turbines are supplied with 800-psi, 800-F steam from four 400,000 lb per hr boilers.

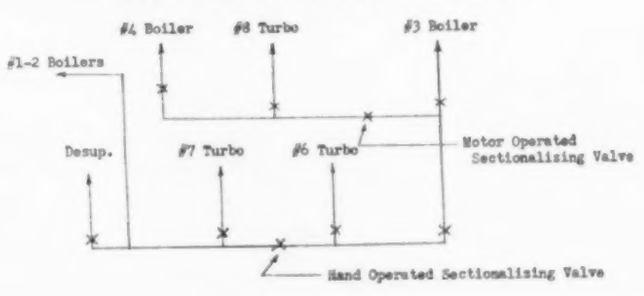


TABLE I

Date of washout	Operating hours	Kw hr generated	Average kwhr per hour	Full load capacity	
				Before washing	After washing
4-26-40	1,397	14,889,000	10,651	10,000	12,700
6-14-42	1,743	17,464,000	10,019	9,300	13,400
12- 4-43	4,494	45,626,000	10,153	9,500	13,000
1- 1-45	4,353	47,842,000	10,990	10,700	13,900
1-14-47	4,608	53,075,000	11,518	10,800	14,000

All the above full load capacity readings taken at 215 psi exhaust pressure with slight variations in the inlet pressure and temperature.

TABLE II

Year	Installed hours	Operating hours	Washouts	Washout hours	Washout per cent availability	Repair hours	Repair per cent availability	Total per cent availability	*Hours unavailable	Kwhr generated x 1000
1936	4,752	4,683	..	...	100.	69	98.55	98.55	..	42,858
1937	8,760	8,607	6	49	99.44	104	98.82	98.26	..	79,790
1938	8,760	8,277	6	59	99.33	424	95.16	94.49	..	76,819
1939	8,760	8,651	6	56	99.36	53	99.40	98.76	..	90,871
1940	8,784	8,673	6	55	99.37	56	99.37	98.74	..	92,857
1941	8,760	8,588	7	73	99.17	99	98.87	98.04	..	74,510
1942	8,760	8,621	6	68	99.22	71	99.19	98.42	..	85,836
1943	8,760	8,653	3	32	99.60	40	99.54	98.70	35	89,694
1944	8,784	7,939	1	7	99.92	820	90.64	90.53	18	87,674
1945	8,760	8,650	4	49	99.44	58	99.34	98.70	3	95,322
1946	8,760	8,707	2	24	99.73	22	99.80	99.30	7	98,068
1947	8,760	8,576	3	37	99.58	147	98.32	97.41	..	98,077
1948	8,784	8,025	2	23	99.73	700	92.03	91.77	36	90,907
Total.....	109,944	106,650	52	532	99.52	2,663	97.58	97.09	99	1,103,283

*Designates time the unit was out of service due to no fault of its own.

TABLE III

Date of washout	Operating hours	Kw hr generated	Average kwhr per hour	Full load capacity	
				Before washing	After washing
7-10-45	10,493	91,539,000	8,723	12,000	12,600
7-28-46	9,080	75,197,000	8,281	11,200	12,500
1-12-48	9,154	91,172,000	9,959	11,900	13,500
3- 6-49	7,991	78,135,000	9,978	11,000	13,500

All of the above full load capacity readings taken at 225 psi exhaust pressure with variations in the inlet pressure and temperature.

TABLE IV

Year	Installed hours	Operating hours	Washouts	Washout hours	Washout per cent availability	Repair hours	Repair per cent availability	Total per cent availability	*Hours unavailable	Kwhr generated x 1000
1940	96	80	..	..	....	16	83.00	83.00	...	324
1941	8,760	8,531	..	..	....	229	97.38	97.38	...	80,581
1942	8,760	8,627	..	..	....	133	98.48	98.48	...	63,183
1943	8,760	8,728	..	..	....	32	99.63	99.63	...	69,115
1944	8,784	7,981	..	..	....	803	90.86	90.86	...	69,460
1945	8,760	8,662	1	16	99.82	60	99.31	98.88	22	75,505
1946	8,760	8,621	2	34	99.61	40	99.54	98.40	65	73,251
1947	8,760	8,744	..	..	....	3	99.90	99.99	13	84,149
1948	8,784	8,099	1	16	99.82	667	92.41	92.22	2	80,395
Total.....	70,224	68,073	4	66	99.92	1,983	97.18	97.08	102	595,963

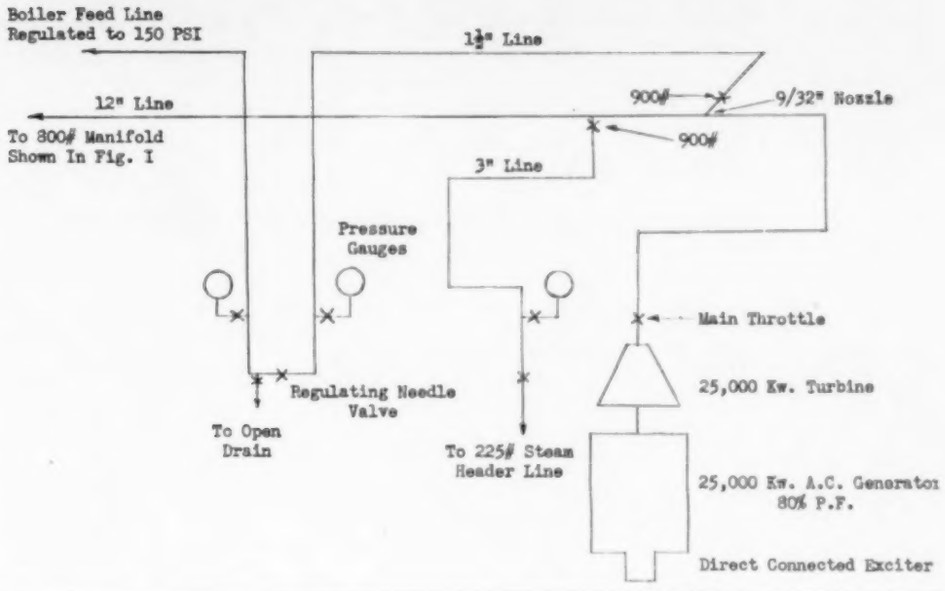


Figure 2 — The sketch shows the piping arrangement for turbines.

The third high pressure unit known as No. 8 is a condensing unit and is unlike the two topping units in formation of deposit with respect to location only. The deposit forms on the buckets or blading of the topping turbines in the exhaust stages, whereas the formation is in the front or high pressure end of the condensing turbine.

Installations of gages throughout all turbines at various points provide positive information as to the locations of the formation. Experiences have taught us the required washing periods from this information. Periodic readings are taken at given inlet and exhaust pressures. Relative pressures on all three turbines due to deposit formation and resultant washing are shown with other pertinent operating information in Tables V, VI, and VII.

While the No. 8 unit installation was rather recent, the availability record is given in Table VIII.

The steam for the operation of these turbines is sup-

TABLE V

No. 6 Washout Period from 7/1/44 to 1/1/45

Date	High pressure steam	High pressure temperature	Low pressure steam	Low pressure temperature	First stage	Fifth stage	Ninth stage	Differential	Kilowatt peak
1944									
7/5	820	820	215	530	705	435	269	54	13.3
7/7	820	780	215	545	706	440	270	55	13.0
7/17	820	810	215	545	707	445	272	57	12.4
7/28	820	825	215	560	708	449	273	58	12.2
8/8	820	825	215	560	708	454	274	59	12.2
8/18	820	810	215	550	709	460	275	60	12.1
8/28	820	815	215	550	709	465	277	62	12.0
9/2	820	820	215	550	710	467	278	63	11.9
9/9	820	790	215	520	710	469	279	64	11.8
9/21	820	840	215	580	711	471	281	66	11.7
9/28	820	815	215	560	712	473	282	67	11.6
10/3	820	820	215	560	712	475	283	68	11.5
10/9	820	815	215	560	712	477	284	69	11.4
10/20	820	785	215	525	712	478	286	71	11.1
10/24	820	825	215	560	712	479	287	72	11.0
11/7	820	845	215	580	713	482	290	75	11.0
11/15	820	810	215	550	713	484	292	77	11.0
11/20	820	815	215	560	713	488	293	78	11.0
11/29	820	805	215	545	713	490	295	80	11.0
12/4	820	830	215	580	714	492	296	81	11.0
12/15	820	825	215	575	714	496	297	82	10.9
12/21	820	820	215	550	714	498	238	83	10.8
12/28	820	825	215	580	714	499	299	84	10.8
1945									
1/1	820	840	215	580	715	500	302	87	10.7
(Off line 2:38 pm., 1/1/45 — On line 4:05 am., 1/2/45) Washout									
1/2	820	830	215	555	710	443	268	53	13.9

Total operating hours between washout periods	4,353
Total kwhr generated between washout periods	47,842,000
Average hourly kwhr between washout periods	10,990

plied by four 400,000 lb per hr boilers and enters a double manifold located in the steel works power house as shown in Figure 1.

While the details of washing arrangements vary slightly, the principle of washing is identical on all three units, therefore, the descriptive information pertaining to No. 8 turbine applies in all cases, a piping arrangement being shown in Figure 2.

TABLE VI

No. 7 Washout Period from 12/26/48 to 1/12/48

Date	High pressure steam	High pressure throttle	High pressure temperature	Low pressure steam	Low pressure temperature	Balance piston	Impulse	First reactance	Second reactance	Differential gage	Kilowatts x 1000	Differential
1946												
12/28	820	820	790	225	545	228	810	775	550	257	12.8	32
1947												
1/18	820	820	825	225	565	228	810	780	552	258	12.6	33
2/26	820	820	830	225	570	228	808	782	555	260	12.2	35
4/3	820	820	820	225	570	228	810	785	556	260	12.0	35
7/25	820	820	840	225	590	228	810	785	556	260	12.0	35
8/18	820	820	850	225	600	228	808	780	556	260	12.0	35
9/9	820	820	850	225	595	228	810	780	558	261	12.2	36
9/24	820	820	830	225	600	228	810	780	559	262	12.1	37
10/20	820	820	825	225	580	228	809	785	560	265	12.0	40
10/28	820	820	830	225	580	228	810	785	562	267	12.0	42
11/19	820	820	820	225	580	228	807	785	570	268	12.0	43
1948												
1/5	830	820	810	225	575	228	806	785	576	270	11.5	45
1/10	835	825	830	225	595	228	810	785	580	272	11.9	48
(Off line 7:09 am., 1/11/48 — On line 8:51 am., 1/12/48) Washout												
1/12	815	810	825	225	570	228	805	780	465	260	13.5	35

Total operating hours between washout periods 9,154
Total kwhr generated between washout periods 91,172,000
Average hourly kwhr between washout periods 9,959

TABLE VII

No. 8 Washout Period from Installation 6/27/47 to 6/4/48

Date	Throttle pressure	Throttle temperature	Primary inlet	Impulse chamber	Gages				Exhaust vacuum	Exhaust temperature	Tail water temperature	Steam flow x 1000	Kilowatts x 1000	River temperature
					1	2	3	4						
8- 8-47	805	800	780	430	430	195	49	1.0	26.9	116	106	278	31.5	79
2-14-48	820	830	800	540	540	245	50	1.5	28.4	98	87	280	31.0	45
5-19-48	815	810	810	585	585	295	54	2.0	27.2	112	103	282	31.0	66
6- 1-48	825	854	820	600	600	300	55	1.5	26.8	116	105	280	30.5	74
(Off line 9:11 am., 6/4/48 — On line 9:24 am., 6/5/48) Washout														
6- 7-48	820	835	810	440	440	205	55	1.0	26.7	119	110	285	33.0	72

Total operating hours since installation date 8,023
Total kwhr generated since installation date 171,230,000
Average hourly kwhr since installation date 21,342

TABLE VIII

Year	Installed hours	Operating hours	Washouts	Washout hours	Washout per cent availability	Repair hours	Repair per cent availability	Total per cent availability	Hours unavailable	Kwhr generated x 1000
1947	4,491	4,277	..	..	....	83	98.15	98.15	131	86,810
1948	8,784	8,719	1	21	99.76	3	99.97	99.73	41	199,960
Total.....	13,275	12,996	1	21	99.85	86	99.35	99.19	172	286,770

The primary concern in washing turbines is the amount of contraction and expansion taking place during the temperature changes, therefore, the temperature changes are made in a manner to enable the gradual movement of the machines, requiring temperature changes ranging from 50 to 100 degrees per hour dependent on the particular machine characteristics.

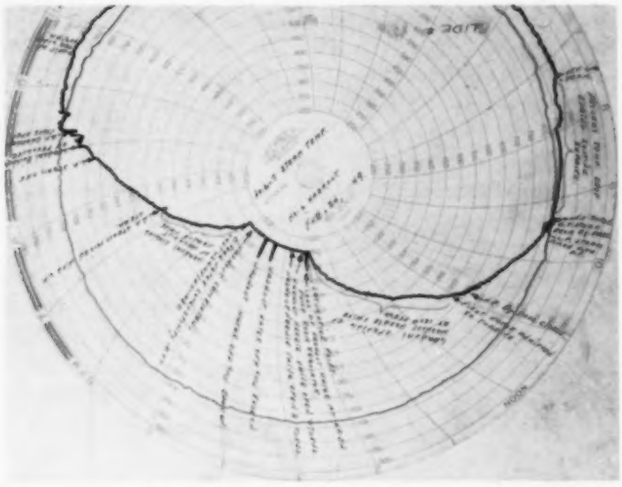


Figure 3 — Temperature chart is given for washout of No. 6 turbine, February 24, 1949. Other line is for steam temperature of No. 7 turbine.

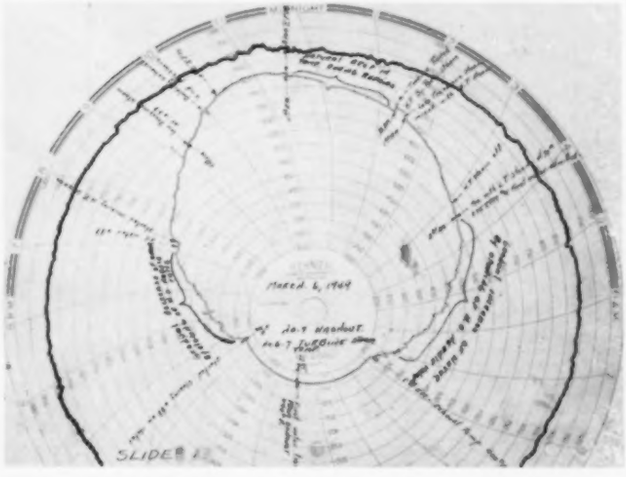
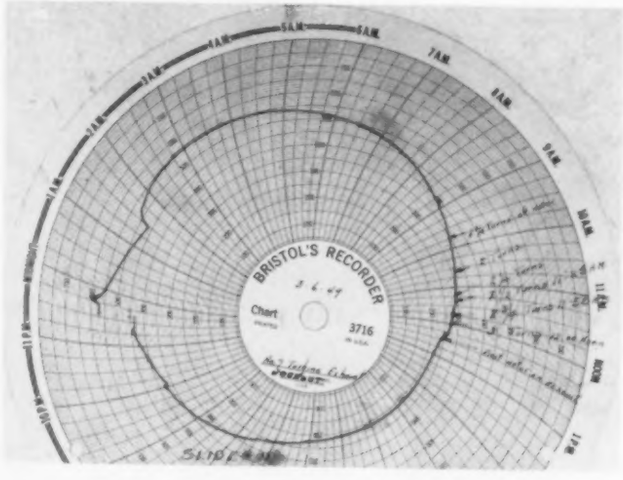


Figure 4 — Chart gives steam temperature during washout of No. 7 turbine on March 6, 1949. Other line is for steam temperature of No. 6 turbine.

Figure 5 — Chart gives exhaust temperature of No. 7 turbine during washout.



WASHING NO. 8 CONDENSING TURBINE

The washout system is designed to be carried out with low steam and water pressures. The steam is supplied through a 3-in. line connected from the 225 psi steam header line while the water is supplied through a 1½-in. line from the boiler feed water line at the boiler house. The steam is controlled by a globe valve, while the water is kept hot by bleeding with a drain and regulated into the steam line by use of a 1½-in. needle valve. The water enters the 12-in. high pressure steam header line to the turbine through a $^{9}/_{32}$-in. nozzle installed in the top of the line on a 45 degree angle, against the flow of steam approximately 30 ft ahead of the main turbine throttle. The steam enters the main 12-in. high pressure steam header line on the bottom approximately 10 ft ahead of the water inlet. The element for the temperature recorder is in the main steam header immediately ahead of the turbine

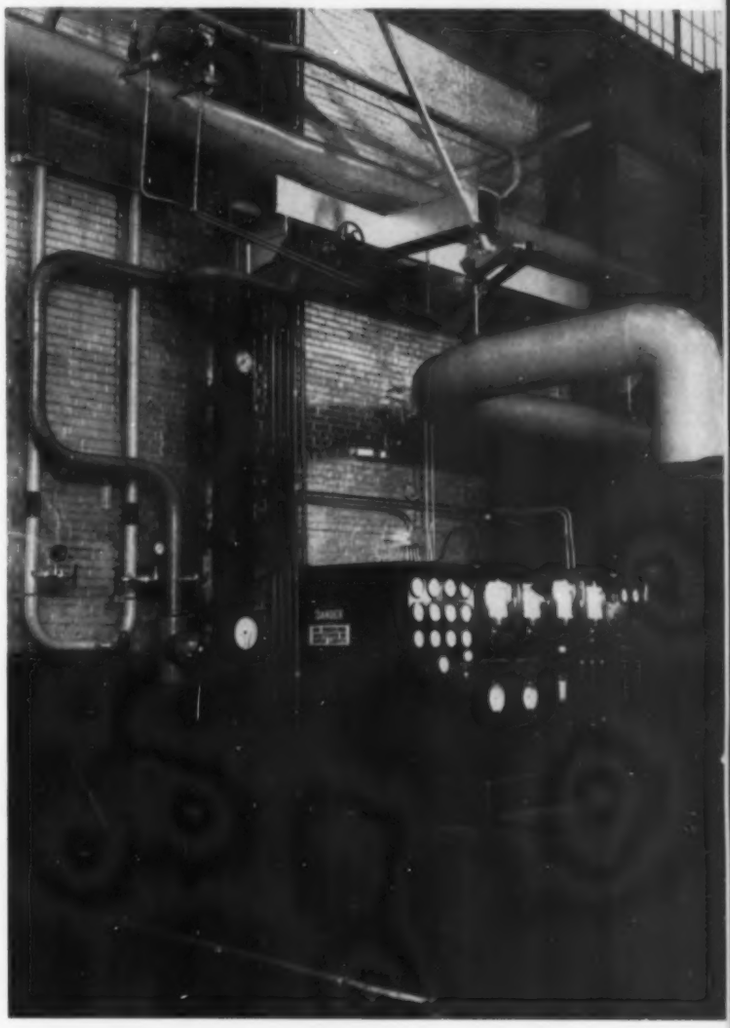


Figure 6 — Steam and water wash lines for No. 8 turbine are shown in the photograph.

Figure 7 — The rotor from a 10,000-kw reactance topping turbine shows the deposit on the exhaust end blading. One blade has been cleaned in the front row, and portions of the two blades have been cleaned in the second row. This deposit was soluble in water.

valves were completely opened. Upon completely opening the throttle valve, the inlet pressure dropped to approximately 3 psi with the unit rolling at 800 rpm.

The low pressure steam at a tempreature of 540 F was admitted to the turbine header to mix with the high pressure steam. As the high pressure by-pass valve was gradually closed, the low pressure valve was opened, decreasing the inlet temperature at the rate of approximately 60 F an hour until the high pressure steam was completely closed at a total temperature of 570 F, or a decrease of 195 F over a period of three hours and ten minutes. The temperature drop continued until a minimum of 490 F was reached with the low pressure steam alone.

In order to attain indicated pressures of inlet steam and water, it was necessary to block the low vacuum trip, drop the vacuum to 10-in. maximum and increase the speed to 1000 rpm. This change of conditions increased the steam pressure to a range of from 23 to 35 psi and the water pressure to a range of from 28 to 53 psi.

Water was gradually increased to conform with the inlet temperature decrease until the saturation point of 315 F temperature was reached, or an average decrease in temperature of 60 F per hour, when the first indications of deposit washing appeared as shown in Sample 3 on the tabulation of conductivity readings (Table IX).

As water was increased, the temperature dropped to a minimum of 260 F. The washing was continued at this temperature for a period of one hour and fifty min-

TABLE IX

Conductivity Readings No. 8 Turbine Washout

June 5, 1948

Sample number	Time taken	Resistance, ohms	Conductivity, mhos	Rpm	Steam pressure	Steam temperature, deg
1	5:55 PM.	51	0.019	1000	25	330
2	6:10 PM.	49	0.020	1000	25	320
3	6:25 PM.	12	0.083	1000	30	315
4	6:40 PM.	9.8	0.091	1000	30	305
5	6:55 PM.	12	0.083	1000	30	160
6	7:10 PM.	14	0.071	1000	35	260
7	*7:25 PM.	19	0.052	980	35	260
8	7:40 PM.	20	0.050	900	35	260
9	7:55 PM.	29	0.034	890	35	260
10	8:10 PM.	35	0.028	800	35	260
11	8:25 PM.	35	0.028	800	35	260
12	8:40 PM.	36	0.027	800	35	260
Boiler feed water		40	0.025			

*Water off 7:10 PM., temperature raised — 65 F — water back on.
All test samples tested on a-c Wheatstone bridge at 150 F.
Test discs spaced at 0.034 in.
Saturation 6:25 PM., washout completed 8:40 PM.

throttle valve. A sketch of this piping arrangement is shown in Figure 2.

The following is an actual washout procedure of the unit completed June 4, 1948: With the machine at rest, the vacuum was built up to 20 in. The 1-in. by-pass valve on the main high pressure steam header valve was opened sufficiently to attain approximately 650 psi pressure at 765 F total temperature and all control

utes with samples being taken at fifteen minute intervals; the resistance measured with an a-c Wheatstone bridge until three successive samples with a resistance of 35 ohms were obtained to compare with the inlet washout water of 40 ohms. Detailed information regarding the testing of samples appears in Table IX.

The water flow was gradually decreased until completely closed, permitting the temperature to rise. A

natural increase in temperature continued with the low pressure steam for a period of two hours and twenty minutes at an average of 80 degrees per hour reaching a maximum of 460 F. At this point, high pressure steam was admitted and mixed with the low pressure steam.

As the low pressure steam was decreased, the high pressure steam was gradually increased, resulting in a gradual increase to a maximum of 670 F at an average of 70 degrees an hour, when the unit was brought to rest and put on the turning gear to permit the inspection of brushes and make minor repairs.

The steam pressure and temperature were customarily raised to the normal operating conditions and the machine rolled over for a period of forty-five minutes at approximately 400 rpm, after which it was brought up to speed and synchronized on the line, the total outage being twenty-four hours of which approximately twenty-one was consumed in the washing procedure. This is considered slightly excessive since it was the initial experience with this unit and the estimated required washing time is from sixteen to eighteen hours under normal conditions.

TABLE X

Date of washout	Operating hours	Kwhr generated	Average kwhr per hour	Full load capacity	
				Before washing	After washing
*6-27-47 6- 5-48	8,023	171,230,000	21,342	30,500	33,000

*Installation date.

Table X gives compiled information regarding the above washout.

The time required to wash the three units varies due to individual machine characteristics. Complete expansion readings are taken at fifteen minute intervals during the entire washout periods. After resuming operations, the load increases are limited to 1000 kw each and every fifteen minutes until full load has been attained.

Figure 8 — The rotor from a 10,000-kw impulse topping turbine shows deposit formation on exhaust end buckets. The deposit has been removed from one complete bucket and a portion of the one adjoining.

DISCUSSION

PRESENTED BY

HOWARD C. GOODRICH, Assistant Superintendent, Carnegie-Illinois Steel Corp., Youngstown, Ohio.

W. K. DUMBAUGH, Superintendent of Power Plants, Weirton Steel Co., Weirton, West Va.

J. H. STRASSBURGER, Manager Service and Maintenance, Weirton Steel Co., Weirton, West Va.

Howard C. Goodrich: Is anything at all done to remove deposits when you had the machine down for a normal periodic inspection?

W. K. Dumbaugh: The only thing we do to remove the deposits during our inspection periods, is to set our turbine rotor outside and wash it with water, by the same means as we do under operation.

J. H. Strassburger: Our power house department has done a good job in keeping these turbines open and clean of deposits. The No. 6 turbo-generator, in the last 12 years, has averaged approximately 11,100 kw for every hour that it has been on the line. The No. 7 unit has not averaged as much as the No. 6 unit because it has not been base loaded, and has a swinging load controlled by back pressure. The No. 8, 25,000-kw generator, which was started in operation in July, 1947, is also not base loaded and operates under a swinging load condition, produced 18,360,000 kwhr in the month of March, 1949, or an average of about 24,700 kw for each hour of operation.

The washing operations as developed and practiced by our power house department during the past 12 years have given us a very high availability and load factor on our 800-lb turbine generated equipment.

BEARING REPAIR

. . . . through a detailed inspection and repair program, increased tonnages have been obtained from mill bearings . . . .

Figure 1 — The bearing is sent to the shop stacked in the same order that it was taken from the mill.

▲ BEARING inspection and bearing repair go together throughout the entire life of a given bearing. Inspection of a bearing, if not followed by such repair as is indicated by the inspection, is a total waste of time and effort. Consequently, both the inspection and the repair should be considered as a unit and carried out together.

The first basic requirement for bearing inspection and repair is the proper area and the necessary facilities for handling the bearing parts through the steps of inspection and repair.

The second requirement is that the area should be in connection with, or adjacent to, the necessary machine shop services that may be required to carry out machine work in connection with the needed repairs.

The facilities, in the bearing shop, should include a surface table, a cleaning tank or degreaser, a crane or hoisting equipment, tools including grinders and buffers, and provision for parts storage.

The types of bearings lending themselves most readily to repair, of course, would be the tapered-roller types of anti-friction bearings. Oil bearings, ball bearings, and other types of roller bearings may be repaired with varying degrees of satisfaction and monetary savings depending specifically on the repair needed.

Bearings may arrive at the bearing shop in either the bearing chocks or housings, in which the bearings are used in the mill, or, in boxes suitable to give safe handling and protection to the bearing while being transported. This condition of receipt would therefore govern the capacity and type of handling equipment needed.

To illustrate the steps necessary to inspect and repair a given bearing, let us first consider a large 4-row tapered-roller bearing.

Figure 1 illustrates a large 4-row tapered-roller bearing as received at the bearing shop on a shipping skid with the box cover removed. The bearing is stacked on the skid in the same sequence as it was removed from the bearing chock at the mill site. This helps in showing whether the spacers were used in the proper sequence and also if any unalined or unequal loading was present during service.

Figure 2 shows the separating of the parts with the use of special hooks made for handling each part as needed.

All of the parts of a given bearing are next cleaned to remove all grease and such contaminants as may be present. This cleaning may be carried out in a vapor degreaser or in an oil-bath type cleaner. In the case of a heated oil-bath type cleaner, oil soluble wetting agents and rust inhibiting agents may be incorporated to give both faster cleaning, and they also add mild rust inhibiting action to the oil film remaining on the metal surfaces after cleaning.

In Figure 3 we see a cone-roller assembly being removed from the cleaning tank, which in this case, is of the oil-bath type.

After cleaning, all parts of the bearing are inspected for any type or kind of metal loss or deformation. In Figure 4 is shown a group of spall spots as they appear

Figure 2 — Special hooks are used in separating the parts in cleaning.

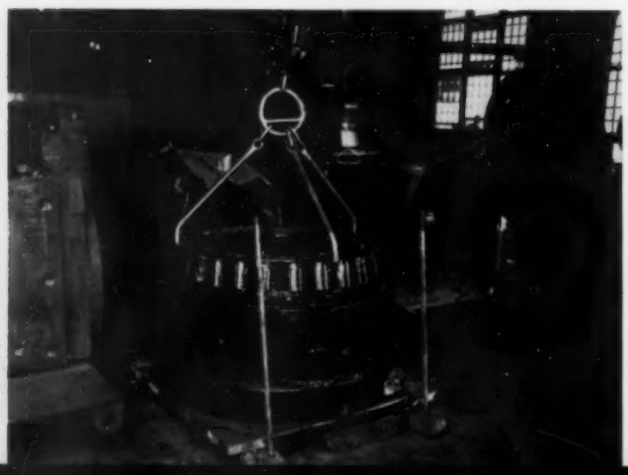
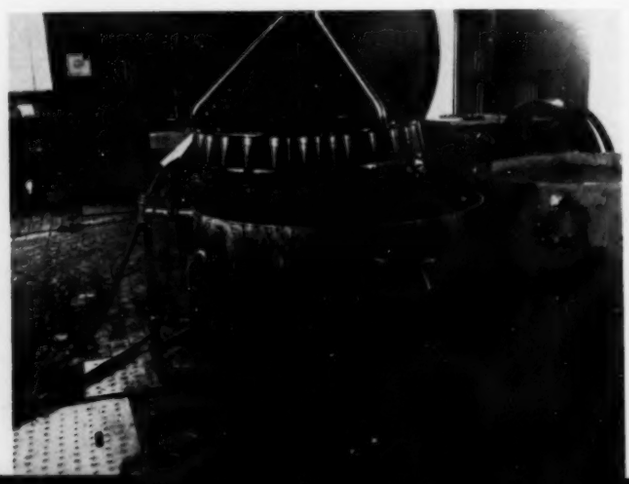


Figure 3 — A cone-roller assembly is being removed from the cleaning tank.



AND INSPECTION

By C. T. LEWIS
Lubrication Engineer
Warren District
Republic Steel Corp.
Warren, Ohio

on a double-cup. The pieces of metal coming loose from the spall spot will of course cause excessive overloading at the points at which they are rolled over by the rollers in their travel, and this overloading causes the bearing surfaces to be marked, or pitted, and can be seen in Figure 4 as a definite pattern covering the entire path of the rollers.

In this particular case, further failure would probably have reduced this bearing to scrap if it had not been for the inspection. It is therefore important that a definite time or service period be set up for given bearings for the interval between each inspection. These periods will vary considerably depending on the service conditions and are governed by the load, speed, temperature and amount of contamination expected in service. Experimentation, by trial and error, will show when the inspection period is of too short a time period and also if of too long a period. If inspections are made too close together, the cost of making the inspections may overshadow the savings gained and if the periods are of too long a time the bearings may be too far gone to make satisfactory repairs.

By moving the "load zone" of the cups of the bearing through 90 degrees rotation at each inspection, the time of fatigue failure can be pushed further into the future. If the bearing is turned "end for end" at the completion of each 360 degrees rotation, the life of the bearing can again be prolonged to some extent.

The repair needed on the double-cup, illustrated in Figure 4, is to grind out all of the flaked or fractured metal from the crater. Figure 5 shows the grinding of the spot with a small portable high-speed hand grinder. This grinding should be complete enough to remove all fissures and visible surface stratified metal. Care should also be taken to work slow enough to avoid burning of the metal by the heat generated in the grinding operation. Different grit stones may be used for the rough grinding and for the finish grinding.

Figure 5 — Spalls are ground enough to remove all fissures and visible surface defects.

After finish grinding of the spall defects, the entire surface of the cup can be buffed to remove the sharp ridges that surround the pits formed from the overloading of the broken bits of metal. The double-cup as shown in Figure 6 is now ready for coating with a rust preventative oil and being stored until all parts of the bearing are ready to be assembled.

For satisfactory inspection and repair of a cone-roller assembly, it is necessary that a roller be removed from the cage ring. In Figure 7 we see a cone-roller assembly with a roller removed and showing a small spall spot on the cone. The repair of a spall spot on the cone follows the same steps as were described in connection with the repair of the double-cup, with the additional precaution being taken to rag pack around the spot being ground and to cover over all other areas to prevent grinding particles from finding their way into places that are inaccessible for cleaning.

If a roller or rollers on a cone-roller assembly have failed without serious failure of the cone, they may be replaced with rollers salvaged from otherwise scrap bearings. In order to replace a given roller it is necessary that the replacement roller matches the existing

Figure 4 — Inspection of this particular bearing reveals spall spots on the double cup.

Figure 6 — After grinding the surface of the double-cup it is buffed.

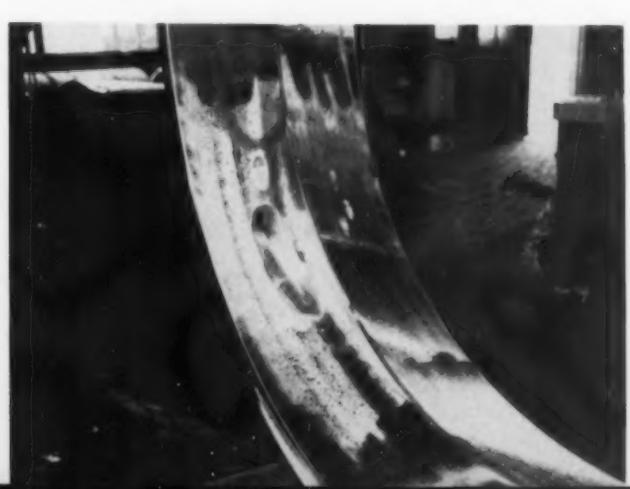


Figure 7 — Spall spots can also be ground when they occur on cones.

rollers in the assembly as to the shoulder height of the roller with respect to a fixed diameter on the tapered length. A micrometer jig is illustrated in use in Figure 8 and shows the shoulder height being measured. With the dimension of a good roller from the assembly in the need of repair once known, it remains to locate a roller of the same dimensions from salvaged rollers removed from otherwise scrap cone-roller assemblies.

If cone repairs are needed on the smaller size bearings having pressed roller cage rings, the individual rollers can be removed by stretching the straight edge of the cage and recrimping after replacement of the rollers. Bearing size and future use govern the extent of repairs desired on any given bearing and should be considered as to the percentage return on the repair cost.

After all parts of the bearing have been inspected and repaired, the parts, exclusive of the spacers, are stacked up on a suitable support and have a load placed upon the top cup to act as a seating load on the rollers. Smaller sized 2-row and 4-row bearings may be loaded by bolting through with a long stud to a surface table on which the bearing is stacked.

Under this loaded condition, as illustrated in Figure 9 using a 2-row bearing, measurements are made to determine the spacer thicknesses required to give the desired amount of lateral end-play within the bearing.

Figure 8 — The shoulder height of a roller used to replace another roller must match the existing rollers in the assembly.

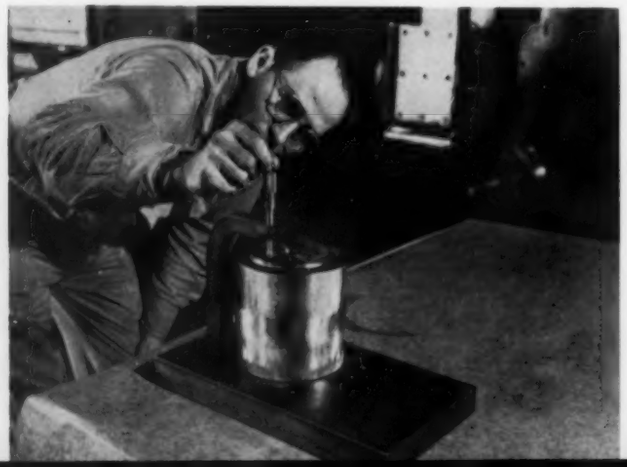


Figure 9 — Spacer must be adjusted to give the desired amount of lateral end-play.

Adjustments, if needed, can be made by grinding either the original spacers or other spacers from the salvage rack, as the case may warrant.

Throughout all work, the bearing parts should be kept as clean as possible and particular care should be exercised when grinding has taken place on a part to be sure that all particles have been cleaned off of the areas exposed to the dust action. It is good practice to use a metal hood, of suitable dimensions to completely cover an assembled bearing, during the times that the bearing is not being worked on. A hood of this type is illustrated in Figure 10.

After the spacers have been ground to the proper dimensions, all parts of the bearing are coated with a rust preventive and again stacked in their proper sequence on the shipping skid ready for return to the mill.

Repairs of the oil-type sleeve bearing will usually be confined to either the journal, or sleeve, and to the bushing, or bearing metal, surface.

Repairs to the journal or sleeve will cover the repolishing of the face in the event of any scuffing or scoring and will be limited by the amount of undersize that can be permitted on the diameter. Satisfactory practice permits approximately $\frac{1}{10}$ of 1 per cent of the diameter for additional clearance as compared to the original optimum clearance established on the

Figure 10 — A mill hood is effective in protecting the bearing from dirt.

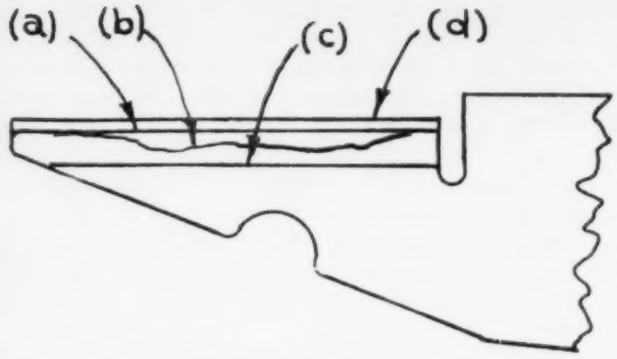


Figure 11 — Seal lip on oil bearing journals may be repaired by a band shrunk on the lip.

new bearing. Further repair to the sleeve may include the return to original diameter with resurfacing of the lip on which the seal ring rides. This repair can be accomplished by turning down the diameter of the lip and shrinking on a band, which in turn may be refinished to the original dimensions and provide a new seal surface. In Figure 11 we can see: (a) the contour of the original seal surface, (b) the surface after it has been worn, (c) the diameter to which it is turned in order to shrink on a band, and (d) the band in place ready to be turned and polished to the original dimensions.

The major repair of oil bearing bushings is the recoating of the bearing metal on the inside surface. Original coatings of either babbitt, cadmium alloy, or other similar alloys may, in most cases, be satisfactorily replaced with a high quality, high-tin-base babbitt. With a suitable mandrel and necessary fixtures, this rebabbitting can be carried out in most babbitt shops as long as care is taken to provide a good tinned surface which is necessary for a good bond between the babbitt and the base metal. By judicious control of temperatures of the babbitt, the bushing shell and the mandrel during rebabbitting, it is possible to hold the warping of the bushing to a minimum and thus make it possible to rebabbitt the same bushing several times without causing it to go out of round too much for further use.

Repairs of ball and other types of roller bearings are mostly limited by the lack of any adjustment to compensate for the normal wear. However, some instances present themselves, from time to time, wherein small scuffs, chips and spalls may be removed or repaired and still give a bearing that can be used for further service.

In conclusion, bearing inspection, if followed by the indicated repair, can give up to fifty per cent more service from the bearing, and thereby give monetary savings nearly in the direct proportion to the size of the bearing being repaired.

DISCUSSION

PRESENTED BY

R. R. LYONS, Engineering Service Department, The Timken Roller Bearing Co., Canton, Ohio.

V. C. ORANGE, Maintenance Service Superintendent, Atlas Steels Limited, Welland, Ontario, Canada.

C. T. LEWIS, Lubrication Engineer, Warren District, Republic Steel Corp., Warren, Ohio.

C. E. PRITCHARD, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio.

HARRY D. ROBB, District Manager, Timken Roller Bearing Co., Pittsburgh, Pa.

WALTER L. DOUGLASS, Lubrication Engineer, Lukens Steel Co., Coatesville, Pa.

JOHN A. TOTH, Chief Engineer, Bantam Bearings Division, Torrington Co., South Bend, Ind.

A. STEWART MURRAY, Asst. Chief Engineer, SKF Industries, Inc., Philadelphia, Pa.

E. W. FISHER, Service Dept., The Garlock Packing Co., Palmyra, N. Y.

R. A. KRAUS, General Mechanical Foreman, Republic Steel Corp., Chicago, Ill.

R. R. Lyons: Mr. Lewis' paper describes the type of bearing maintenance that service men dream of and very seldom encounter. I believe that we all agree that any piece of machinery can be repaired better in the plant of the manufacturer than by the user, and that certainly applies to bearings, for there are special tools and "know how" available in the builder's plant that are not available elsewhere.

Of course, there are times when on-the-spot repair is necessary and equipment and properly trained workmen for these jobs are well worth while. Much of the equipment mentioned in Mr. Lewis' paper can be found in any good mill machine shop, as the items mentioned are used for many other jobs.

At one point in his paper, Mr. Lewis says, "If cone repairs are needed on the smaller size bearings having pressed roller cage rings, the individual rollers can be removed by stretching the straight edge of the cage and recrimping after replacement of the rollers." I doubt that this method of repair would be very satisfactory, for the pressed metal cages are very hard to stretch and to do a good job of "recrimping" a special tool known as a "closing-in-die" is used. To do this job without the special tools used in making these bearings is very difficult.

However, on-the-spot repairs have been made on steel mill work roll bearings, etc., having pressed steel cages by cutting through the cage with a hack saw, parallel to and midway between two rolls at one spot only. This will allow the cage to spring open and the rolls can be removed and replaced as desired. The cage is then placed in a clamp with just enough pressure to close the saw cut, care being taken to prevent distortion. The saw cut is then electric welded with a light rod to avoid excessive heat, or the saw cut can be brazed if desired. The utmost care must be taken to prevent annealing of the bearing race or adjacent rolls while welding or brazing the cage. After welding, all excess metal is removed from the cage.

If this type of repair is made on a work roll bearing, or similar application, the bearing so repaired should be placed in one of the slower speed stands, for there is liable to be some unbalance of the cage, which would cause vibration at high speed. This is the only point I

find to criticize in Mr. Lewis' paper and again wish to say that he has covered the subject thoroughly.

V. C. Orange: In Figure 4, Mr. Lewis showed a small portion which they have ground out. I would like to know if Mr. Lewis knows whether any attempt was made to regain this lost surface by filling in or whether that is just passed up? Also, what area can this small spot be? What percentage of the bearing area at this spot could be gone, before he would feel that it was too far gone? I would like to know if they refill that spot, or whether it is put into use when it is ground that way to prevent any further spalling at that point.

C. T. Lewis: I would not recommend that particular section being placed in a load zone. We have never attempted to replace any metal removed. It is primarily a means of stopping further flaking, and the continual addition of metal particles to the roller path. As long as the bad spot is kept in the no-load zone, we have found that if you maintain an edge contact on each end of the rollers, you can maintain an actual rolling contact and do not let the roller slide or skid.

V. C. Orange: In other words, you must bridge it.

C. T. Lewis: That is right. It will be satisfactory if you can show sound metal along both edges of the cup, in some cases it is not nearly as wide as illustrated. We have had grinding take place almost out to the outer edge. If you can hold a half-inch or better on each side of the roller, it will be satisfactory.

C. E. Pritchard: In the no-load zone?

C. T. Lewis: That is right. Don't try to put the repair area in the load zone. Does that answer your question?

C. E. Pritchard: Do you want to comment further with reference to the question covering crimping of the bearings after the necessary repairs have been made?

C. T. Lewis: As far as the thickness of the metal on the present cage is concerned, it may be satisfactory to weld, if the welder is completely sold on all your rehabilitation programs. Most welders though, could not be depended upon to get a satisfactory weld without endangering the heat treatment of the rollers on the cone. It is really a job to take one of those cages and then recrimp it, and stretch it, but it has been done with very satisfactory results.

Harry D. Robb: The bearing shown in the photograph is 42 in. outside diameter and apparently shows a spall of approximately 4 in. If this spall extended even to as much as one-third of the area of the bearing, it would have no detrimental effect in the operation of the bearing provided this spalled area was placed in the no load zone.

Walter Douglass: I would also like to ask Mr. Lewis his opinion on the necessity or advisability of magnaflux examination of roller bearings.

C. T. Lewis: We do not possess, in our shop, any magnaflux equipment. However, in the case of the rollers, the magnaflux would probably give you a fair warning that you were going to have trouble in the future. The only problem which you would probably encounter on a test of this type would be where a roller has started to fail or advance sufficiently at the point of failure, to show up on the magnaflux test. The rollers, for the most part, give you considerably less trouble than the cups.

It is suggested that, if necessary, an additional step might be taken where by the parts in question could be checked with a reflectoscope unit thereby offering advanced warning of subsurface cracks which would not be indicated by the magnaflux test.

John A. Toth: In answer to the gentleman's question regarding magnaflux check of bearings removed from service, I would recommend this type of check on rollers and races as individual parts only.

An accurate check cannot be made on a bearing assembly section because of necessity for magnetic field and compound coating which can only be maintained on individual bearing elements that can be handled satisfactorily and inspected according to established standards.

All bearing elements must be thoroughly clean and free from surface abrasion to allow for accurate check results. This process would not be practical because of costs and the time consuming element involved.

A. Stewart Murray: Magnaflux indications do not of necessity indicate a lack of quality but rather, like all statistics, they must be interpreted. There is considerable reliable laboratory data to disprove that the magnaflux process can be compared to a traffic light with its red and green signals. Excepting indications of cracks, a bearing that has been operated for a substantial period and appears in good condition to visual examination, can be considered a good bearing notwithstanding any minor magnaflux indications to the contrary. It is also a pretty good crosscheck on the magnaflux standard that may have been established for new bearings.

E. W. Fisher: We have been talking about bearings and I have been drawing a comparison between oil seals and bearings, and I am very glad to see he recognizes that the oil seal needs a good surface to run on, and certainly should be considered in any bearing repair program. We have to be careful to obtain a good surface for the seal to bear on and to keep this surface concentric with the bearing proper.

R. A. Kraus: We would appreciate comment and further discussion on the author's experience concerning the amount and scope of records necessary to make a program of this sort function properly, and secondly, we would be interested in knowing if at any time, experience had been obtained on your repair of bearings that had previously been forwarded to bearing companies for repair and had been considered by them as unfit for further service.

C. T. Lewis: For the proper evaluation of bearing life, records should be kept on each bearing, whether the bearing is a new one or a repaired bearing. In the case of a new bearing the record should show the bearing serial number and the full service record of tonnages obtained, with notations on mill accidents such as cobbles, roll breakage, etc. Records on repaired bearings should contain all the information included on the new bearing record and in addition should show the tonnages obtained on each separate part and serial part numbers for the parts that may have been assembled from salvaged parts from several different bearings.

As for the case of making repairs on bearings that have been classed as non-repairable by the supplier, it may be stated that such repairs have been made and tonnages received which more than justified the repair from an economical standpoint.

INSTRUMENT MAINTENANCE

By E. T. MORTSON
Superintendent Power and Fuel
National Tube Co.
McKeesport, Pa.

. . . . steelmaking processes are depending more and more on instrument control . . . . consequently, instrument maintenance becomes a vital part of the steelmaker's job . . . .

▲ THE use of instruments in steelmaking has increased tremendously in the past decade. Instruments have become an integral part of process design in every phase of steelmaking while maintenance and service of the instruments have become of first importance in operations. However, the instrument maintenance department's other functions are to assist in the engineering and development of new applications, the tabulation of metered quantities of all utilities consumed and produced, and finally, the continuous training of personnel to meet ever changing developments in equipment and applications.

The operation of a blast furnace using controllers and instruments has changed considerably during the past 10 to 15 years as indicated by the following list of instruments now in use:

1. Hot blast temperature controller with automatic humidity correction.
2. Hot blast stove temperature and combustion controller.
3. Hot blast pressure and temperature recorders and indicators.
4. Bell movement recorder.
5. Top gas temperature and recorders and indicators.
6. Stockline recorder.
7. Special instruments for special purposes.

This present day instrument panel compared to the pressure, hot blast temperature, and top temperature indicators of 15 years ago, requires more than just someone to maintain a few instruments in their spare time. The instrument maintenance man must know the process as well as the instruments to adjust and repair intelligently the control and measuring equipment.

From the making of iron, let us take a look at the advancement in use of instruments in steelmaking. The open hearth furnace with automatic reversals, fuel/air ratio controllers, furnace pressure controllers, roof temperature controllers, bath pyrometers, flame indication pyrometers, oil, gas and tar meters, recording and indicating gages, requires more than a check of gas and oil meters and recalibration of pressure gages, previously the only instruments in use on these furnaces.

The improved heating in soaking pit practice is another indication of the advantages of instruments and control in this important phase of steel processing. The old soaking pit, using coke oven gas or producer gas, had no instruments, or if any, perhaps an occasional meter or pressure gage. The heating was controlled entirely by the heaters with the result that heating practice varied, depending upon the heater. Today soaking pits are equipped with indicating and recording meters and controllers for fuels and air, temperature recording controllers, damper controllers, and gas pressure controllers. Predetermined settings of controllers will permit duplicate heating cycles regardless of the operators. This equpiment must be checked and serviced daily by competent instrument servicemen to maintain the close control required.

The trend toward dependence upon instruments and control is further indicated when comparing a sloping hearth with a rotary hearth billet heating furnace. The latter, as well as its instruments and control, were designed and built for specific purposes.

The roll-down sloping hearth furnace when originally built was equipped with only a fuel meter, pressure gage and damper position indicator. Instruments and control to operate fuel and air input, maintain proper furnace temperatures, recuperators to provide preheated air with recording and indicating instruments, were later installed to remove certain controllable variables in the heating process. These installations have been beneficial in removing some of the variables. However, recently designed rotary hearth furnaces, with proper controls incorporated in this design, have not only further improved the heating process, but the operation of the furnace depends entirely upon the proper operation of the controls and recording equipment. In fact, the operation of these furnaces is often controlled by an individual trained under the supervision of the instrument department, so that all except major overhauling of equipment can be done at frequent intervals and on the spot.

In many instances, even today, instruments are added to operating equipment to obtain additional information which may be a guide to improved operations.

The changes in the process of steelmaking and finishing have increased the need for proper instrument

maintenance. The completely instrumentized and controlled open hearth furnace would be difficult to operate manually because no operator can adjust the furnace for changing operating conditions as well as can be done with control equipment and instruments. No manually operated soaking pit can be operated as continuously and as effectively as an automatically controlled pit. To prove such a statement we have, in the past, operated furnaces with the temperature, pressure, and fuel/air ratio control equipment covered and permitted the operator to manipulate the furnaces according to his own method with a record of various temperatures, pressure and ratio being recorded on the covered instruments. The results were astounding in that in every case variations in every phase were several times the variations that occurred when using control. Such a test is the best sales talk one can present to the skeptical furnace operator.

As previously pointed out, instrumentation is now a definite part of any new process, or improvement in process, in steelmaking. It has attained such prominence because of the continued advances being made in instruments and control. The pyrometers of 10 years ago with their many moving parts cannot be compared with the electronic instruments of today. Fuel/air ratio control instruments of today can and will perform without too much attention, while similar equipment 10 to 15 years ago required special handling perhaps by some individual who managed to discover the technique of fine adjustments. Instruments and controls today will permit close adjustments of variables by the manipulation of valves, dampers, fans, fuel rates in proper sequence, without interfering with the process in any way while continuing to duplicate cycles of operation as required.

In any instrument problem the purpose must be known to properly determine the value of any process or equipment. Instrumentation in steelmaking, as in many processes, must meet one or all of the following conditions:

1. Provide production or operation of a facility.
2. Reduce cost of operations.
3. Improve quality and uniformity of operation or product.
4. Improve safety of operation.

The heating of steel in various stages of processing is now performed in furnaces designed especially for some particular operation. Because of their design, these furnaces could not be operated manually due to the large number of burners required to maintain proper heating conditions. In this instance, it would have been impossible to design and operate such a heating facility if instruments and controls were not available.

The use of instruments and controls to obtain cost reductions has been borne out in many steel heating processes in that improvement in fuel utilization and furnace maintenance, as well as increased production through stabilized heating, has more than compensated for the cost of such equipment. A typical example of cost reduction in maintenance can be found in the use of roof pyrometers on open hearth furnaces which, when properly operated, increased furnace roof life approximately 30 per cent.

The use of instruments and controls for improvement in quality has been made necessary because the close metallurgical requirements for quality product in heating would be impossible under manual control. In fact, the continuous adjustments required for quality control in many processes would have been impossible 10 to 15 years ago because instruments and controls were not then available.

One of the problems of present day operation and one foremost in steel plant operations, is safety. Instruments and controls are available to shut down furnaces, boilers, etc., upon failure of some particular part, overheating, loss of power, fuel or air supply. In addition, the use of instruments permits the operators to detect trouble, and correct it before damage occurs.

One of the instrument department's functions is to recommend the use of control instruments that meet the following requirements:

1. That the instrument or control is properly designed, rugged, reliable and will perform intended functions.
2. That the instrument or control is properly installed to measure and control the variable.
3. That the instrument or control be maintained in good operating condition, properly calibrated and adjusted to meet designed conditions.

Proper selection of equipment for measurement and control for a particular process can often be done more effectively by the instrument service department and plant personnel because of their previous experience with the process and quality of process control desired than by the manufacturers of the equipment on which instruments are used. Simplicity in instrumentation should be one of the first considerations. Complicated instruments or controls that require constant attention, and in the end not work satisfactorily, should be eliminated as far as possible.

The main functions of an instrument service department in a steel mill, once the instruments or controls are placed in operation, are to perform the following duties:

1. Maintain instruments in good working order. This can be accomplished by having a preventive maintenance schedule, at selected intervals with various parts that must be checked, parts to be greased, cleaned, oiled, packing to be replaced, etc.

In measuring devices, the measuring element must be examined at specified intervals. In spite of such precautions, a large part of instrument service is to handle emergency breakdowns in equipment, such service to be available in most cases at all times.

2. Proper adjustment of instruments and control. Adjustments are especially important when starting up new equipment. The instrument man properly instructed can, by trial and error, adjust the instruments to work as designed. Observance of operating conditions on instrument charts will permit logical changes and result in the best instrument and control settings. The trial and error method has, in many cases, proved effective and very practical.

3. Instruments and control are often advantageous in diagnosing trouble.

Unsatisfactory operations are often detected by the use of instruments. Proper cooperation between the operating department and instrument service depart-

ment may disclose the actual conditions so clearly that proper steps can be taken to eliminate future difficulty. Many times proper instrument records will disclose a change which may have occurred in the process and permit correction to be made at once.

4. Test of instrument accuracy.

No hard and fast rule can be set down to determine frequency of checking instruments. This factor must be investigated by the instrument service department and may depend upon quality standards for the process, closeness of control or instrumentation required, ruggedness and reliability of instruments, and experience with the equipment installed. The instruments and controls of today usually maintain their accuracy better than those instruments of a decade or more ago.

It has been our experience that a check of accuracy for the following types of instrument should be made as follows:

Meter: Mechanical-electrical—One month period.
Pyrometer: Mechanical type—One month period.
Pyrometer: Electronic type—One month period.
Combustion Control —Daily to weekly.
Recording pressure gage —Three months.
Indicating gage —As required.

The above includes the majority of the instruments used in steel mills with the exception of special applications requiring unusual attention.

5. Tabulation and records of utilities and production.

The tabulation of quantities of various utilities used by the many operating departments in a steel mill entails a great deal of routine work to maintain accurate records. Hundreds of recording charts showing pressure, flows, temperature, etc., are handled daily by the chart men and clerks. They record on large log sheets for permanent record the data taken from charts by planimeter or by integrator reading. Day to day balances between generated and consumed utilities are maintained.

Such records are invaluable in determining possible losses from inefficiency or leakage. Further, it is the duty of the chart changer to notify the instrument repair supervisor when an instrument is not functioning properly. In addition, the information accumulated daily is used by the cost department in maintaining daily cost information and is used by the power and fuel department to calculate monthly distribution of all utilities, generation and consumption, throughout the plant. The use of instruments, especially flow meters, except perhaps in new plants, has not reached sufficient quantity to provide proper information for today's accounting requirements.

6. Testing and instrument applications.

Regardless of how well some process or piece of equipment is operating, continuous advances are being made in every phase of steelmaking by regulating, through instrumentation, variables previously thought uncontrollable. Such changes require close cooperation between the operating departments and the instrument maintenance section so that proper application and utilization of instrumentation will function as required. Testing of new equipment to determine whether or not it meets the original specification is also a function of the instrument maintenance section. Efficiency data sheets on boilers and furnaces to determine the most satisfactory operating methods are made at such intervals as changes in operating practices or demands require.

Each plant, and we refer particularly to steel plants, has its individual problems because of variations in the process, different products and closeness of control required.

7. Personnel in an instrument service department.

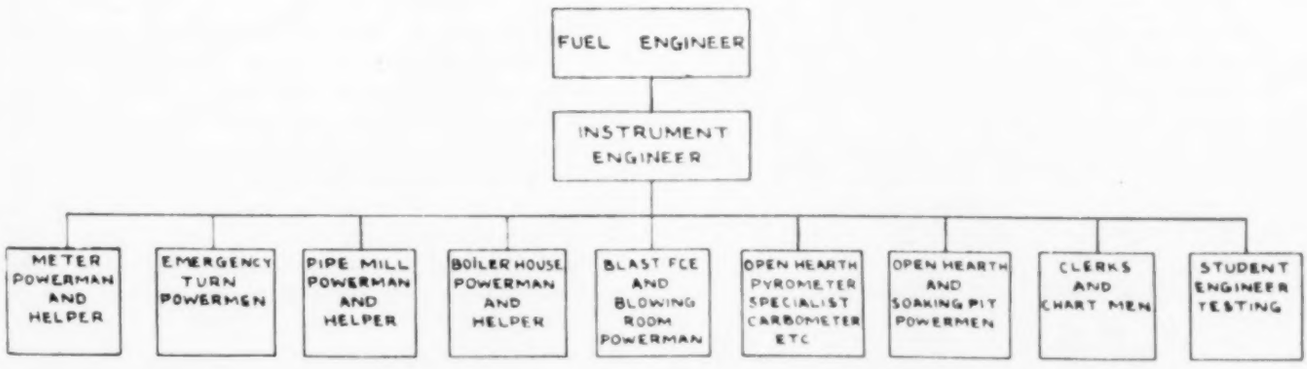
At National works of National Tube Co. we have approximately thirty different types of instruments and controllers requiring an organization as shown in Figure 1.

The direction of the instrument and control service in steel plants is generally by those familiar with fuel and power problems. The operating man, in most cases, is not trained in this specialized work and, with his many other problems, finds it more advantageous to use the service of an instrument maintenance section. Furthermore, he may not require the full time service of an instrument service man whose time can profitably be divided so as to handle several departments. To operating men, instrument repairs are only an incident in production, while instrument men regard them as of the utmost importance.

The supervisors of such a department should have technical training and preferably considerable experience in steel plant instrument work.

The instrument men, especially those assigned to

Figure 1 — Personnel chart for instrument group at National Works of National Tube Co.


FUEL ENGINEER
INSTRUMENT ENGINEER
METER POWERMAN AND HELPER
EMERGENCY TURN POWERMEN
PIPE MILL POWERMAN AND HELPER
BOILER HOUSE POWERMAN AND HELPER
BLAST FCE AND BLOWING ROOM POWERMAN
OPEN HEARTH PYROMETER SPECIALIST CARBOMETER ETC
OPEN HEARTH AND SOAKING PIT POWERMEN
CLERKS AND CHART MEN
STUDENT ENGINEER TESTING

zones, must have instrument training and be very familiar with the process concerned so that they know when and how to make repairs and adjustments without upsetting the process.

The instrument service department during and in the immediate post-war era had difficulty in obtaining qualified men. In fact, many of the personnel were hired without sufficient education or training, requiring considerable on-the-job training to become efficient. Most of the men employed today for regular instrument maintenance are high school graduates with some experience gained in watchmaking schools, radio schools or in specialized army and navy training.

National works of National Tube Co. in the past few years has adopted the practice of sending men to instrument schools provided and maintained by instrument manufacturers. This training has probably been the most effective method of training instrument employees to date.

Additional training is obtained by the use of detailed instruction data from instrument manufacturers, discussions between supervisors and men regarding difficulties that develop, and information obtained from instrument manufacturers service men. Continuous checking of an instrument repairman's work by his supervisor, and correction when needed, are also required.

The instrument service department supervisor, having a small department, can employ the men to best advantage, as he will be aware of the particular phases of instrumentation and control each man is most capable of performing, continuously instructing him in all work so that he may become more proficient.

Equipment required for steel plant instrument and control maintenance is listed as follows:

1. Muffle furnace for checking thermocouples.
2. Standard thermocouples—certified by Bureau of Standards.
3. Surface temperature pyrometer.
4. Optical pyrometer (including checking equipment).
5. Portable flow meters.
6. Volt-ohm-mil-ammeter.
7. Dead weight tester.
8. Furnace atmosphere indicator.
9. Tube tester.
10. Millivolt meter.
11. Portable potentiometer.
12. Electric drill.
13. Six-in. bench grinder.
14. Pipe dies, cutters with vise.
15. Socket, tap, box and pipe wrenches.
16. Soldering iron.
17. Miscellaneous small tools.
18. Small lathe.
19. Small gas welding outfit.
20. Set of portable telephones for field communications.
21. Complete set of pressure test gages.
22. Hand tachometer.
23. Sling psychrometer.
24. Portable and inclined draft gages.
25. Stop watches.
26. Orsat equipment.
27. Portable radiation pyrometers.
28. Displacement meter.
29. Instrument maintenance manuals.

Personal tools for instrument maintenance men is listed as follows:

1. Flashlight.
2. Screwdrivers.
3. Crescent wrenches.
4. Small pipe wrenches.
5. Cutting pliers
6. Voltage tester.
7. Allen and Bristol wrenches.
8. Special wrenches for major instruments.
9. Small machinist hammers.
10. Tweezers.
11. Small box type wrenches.
12. Pen cleaning wires.
13. Tool box.

The items mentioned under personal tools for instrument maintenance men are normally supplied to each man. The shop equipment mentioned will be present in a well arranged shop serviced by an attendant.

In conclusion, we must all remember that the field of instrumentation is rapidly expanding, requiring more and better trained instrument service men.

DISCUSSION

PRESENTED BY

R. A. LAMBERT, Superintendent, Steam Efficiency and Combustion Dept., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

E. T. MORTSON, Superintendent Power and Fuel National Tube Co., McKeesport, Pa.

FRED H. BREMER, Combustion Engineer, National Supply Co., Ambridge, Pa.

FRED N. HAYS, Power Planning Engineer, Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

R. A. Lambert: Would the author explain what provision he makes for testing of fuels, that is, the analyzing of gases and fuel oils, etc. What is the setup to do this?

E. T. Mortson: Fuel oil is checked at various intervals by having the fuel station operator collect small samples from each car as it is unloaded, and the composite samples of say one week are sent to the chemical laboratory for complete analysis. Analyzing flue gas is performed by a group of powermen from that area under direction of fuel engineer. Orsat equipment or a continuous analyzer is used depending upon conditions.

F. H. Bremmer: I would like to add a thought which should provoke further discussion. In the use of various instruments for furnace temperature control, we feel that some furnaces which industry uses cannot be controlled automatically. We refer mainly to slab and bloom heating facilities of the triple zone firing types. Along the same line, we feel that the refractory as well as the heat resistance alloy makers must show more progress to keep up with the furnace designer.

E. T. Mortson: The heating of blooms or slabs in continuous furnaces automatically has and is still a prob-

lem primarily because instruments to accurately measure slab or billet temperature in hazy furnace atmospheres have not been dependable. However, the use of closed end radiation pyrometer to give an indication of the trend in furnace temperature can be made to operate more effectively than manual control.

Fred N. Hays: I would like to ask you concerning the method used in checking furnace pressure recorders. In the last 15 years, as you know, we have installed furnace pressure recorders on practically every furnace. How do we check them? As I walk through the plants, I see one furnace with a pressure reading of $^{10}/_{100}$ and another furnace with $^{8}/_{100}$, and often note that the furnace with $^{8}/_{100}$ has a higher actual pressure than the one with $^{10}/_{100}$.

E. T. Mortson: I agree with Mr. Hays that slight differences in furnace pressure occur between furnaces of like construction. Variations in furnace operating pressures may vary slightly due to some very slight differences in operation and construction as no two furnaces work exactly alike. Our furnace pressure gages are checked by inclined draft gage, the most accurate gage we have available.

Fred N. Hays: Is an inclined gage accurate enough to check furnace pressure recorders? An error of $^{1}/_{100}$ of an inch of water represents a considerable difference in furnace pressure and consequent air infiltration. I wonder if the method of checking these instruments has kept pace with the increasing use of furnace pressure recorders and controls on furnaces.

E. T. Mortson: The question of inclined draft gage accuracy is one of long standing and may not be laboratory precision. However, it is our thought that actual furnace pressure is not as accurate as one is led to believe; such accuracy depends upon location of pressure point, length of pressure line with an error in one or the other affecting pressure readings more than the slight inaccuracy of the inclined draft gage.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

MAINTENANCE OF

. . . . through simple field procedures, reliable operation of equipment requiring insulating oil may be assured . . . .

▲ AS electrical engineers, particularly those responsible for the operation of the equipment, our interest is to keep such apparatus in proper condition for continued functioning. Preventive maintenance, rather than repair after failure, is certainly our aim. Electrical equipment maintenance involves a wide field and knowledge of a great many different, though related subjects, among which we find the complicated subject of insulating oils.

The functions of oil are relatively simple—to serve as an insulator, heat transfer agent, or arc interrupting device, and the properties to effectively serve these purposes are apparently quite readily obtained by oil refiners. The major difficulty lies in that so many factors affect the stability of oil that it needs attention to assure continued proper performance.

Oil might be looked upon and perhaps often is as a necessary evil, and along with our efforts to improve oil performance, there has also been a trend to replace it, as has been done in many lower voltage transformers and in a great many circuit interrupting devices. It would appear that we will have oil and oil filled equipment for a long time, and every electrical engineer should recognize this component of our equipment and give it a balanced consideration in his maintenance approach. Let us be balanced, however, and not jump to conclusions and blame oil for some of our difficulties where perhaps some other influence may be responsible.

Maintenance of insulating oils is a subject that one cannot jump into, it is the type of thing where background and history serve as a means of better appreciation of the subject. In reviewing the past use of oil, we find, as in most any field, a set of ever changing circumstances and influences, and the importance attached to insulating oil has varied from time to time. In the period of a decade or two ago, considerable attention was devoted to insulating oils in both circuit breakers and transformers, due to the unusual number of difficulties then being experienced. The equipment which was in service at that time was of older design, and during that period, with electrical systems rapidly expanding, conditions were such that overloaded transformers and over dutied circuit breakers were quite common. The numerous failures resulting were, in the light of the information then available, inescapable, and in an effort to analyze all the factors involved, oil was brought into major prominence.

The oils which were then prevalent were of a considerable number and variety, and no agreements had been reached as to the interchangeability of various trade name oils as between manufacturer's equipment or as between circuit breakers and transformers. As of necessity, we were forced to maintain stocks of a considerable number of different oils and this of course, introduced the problem of different grades becoming contaminated with others, and brought about an oil situation which at best, was very unsatisfactory.

At that time, we carried stocks of one electrical manufacturer's oils, A, B, and C, and in addition, a class which we then called 2200-volt oil, which was a mixture of all of these grades. We also maintained stocks of another electrical manufacturer's Nos. 10, 21, and 6, as well as a transformer oil known as Patra No. 7. At the same time, we were attempting to keep circuit breaker oils and transformer oils segregated so that it is little wonder that some of our oils became mixed and of unknown grade and origin. In an effort to eliminate the oil factor as the cause of equipment failures, investigations were made as to the quality and stability of the oils that were then in service, for continued service, and investigations were also conducted regarding methods of reconditioning oils, both mechanical and chemical. The results of these investigations, both on our part and investigations conducted by the Insulating Oil Subcommittee of the Electrical Apparatus Committee of the N.E.L.A. as published in N.E.L.A. publication No. 169 dated December, 1931, on the "Performance of Insulating Oil in Circuit Breakers," and the work of this same committee as published in the Edison Electric Institute Bulletin dated May, 1933, applying to Insulating Oil in Transformers, may be summarized by quoting from the reports of the Insulating Oil Subcommittee: "The data summarized in this report would indicate that standard oils now supplied by electrical equipment manufacturers for transformer and/or circuit breaker service would be suitable for use in any electrical apparatus manufacturers' modern oil insulated transformer and/or circuit breaker under comparable climatic conditions." During the course of the preliminary investigations run on oil in connection with the work referred to above, numerous mechanical, electrical, and chemical tests were devised to indicate both the type and quality of insulating oils, and many of these tests, which were adopted by the A.S.T.M. are still in use, and with the addition of still newer tests, are applied in following the operating condition of our insulating oils. We feel that these give us reasonable assurance of continued satisfactory performance.

In attempting to understand the problem, it might be well to inquire as to what is electrical insulating oil. We find it is not a simple compound, but a mixture of a number of large and complex hydro-carbon molecules. Its chemical make-up as we receive it is a variable, affected by the origin of the crude from which it was extracted, and the degree of refining it has been subject to, and lately there is the possibility of inhibitors having been added. One might say that oil has a personality, determined by its heredity and previous environment. Physically, its quality is determined by such tests as pour point, flash and fire points, viscosity, and gravity, and these qualities are generally consistent in oils as received. But once oil is placed in equipment, it begins a new life and is exposed to new associates under

INSULATING OILS

By H. H. MARSH, JR.
General Superintendent Substations
and Shops
Duquesne Light Co.
Pittsburgh, Pa.

a variety of conditions. The service records of oils in the past have had influence on the refiners too, in that it has been shown that highly refined oils, while being resistant to sludge formation, were found to produce high acids which react unfavorably on both metals and insulation, and produce water as one of the accompanying reactions during oxidation. Some of the earlier oils which were not highly refined were less acid forming but sludged rather rapidly, particularly at the higher temperatures coming into acceptance. Our modern oils seem to be moderately refined and consist largely of a mixture of naphthenic and aromatic hydro-carbons, and an investigation of the molecular structure of these fractions gives some indication of the complexity of the problem of studying the reactions which these insulating oils may enter into with oxygen, moisture, and other deteriorating influences.

With an appreciation of the complexity of the chemical structure of oil and with some knowledge of the main deteriorating influences, it should follow that control of environment might be one approach to influencing behavior. Certainly a suitable new oil, if kept dry, free from soluble contaminants, and used in an inert atmosphere, has never been known to give trouble and some deteriorating influences are within our control.

Temperature is another big factor in the speed of reactions, and loading equipment on a temperature basis has introduced higher temperatures on oil. When the generally accepted rule of doubling chemical reaction speed with each 8 to 10 C rise in temperature is applied to oils, we can too readily cut our oil life in halves, quarters, or eighths, by running 10, 20, or 30 C higher temperatures.

We do not always start with good new oils and we do not always have control of the deteriorating influences. Much of our oil is of unknown origin as to crude, degree of refining, and past service history, and much of our equipment does not lend itself to economical conversion to modern gas tight construction. What we do is of course, determined by economic factors, and what one company may do may not apply to another.

Assuming that we have done everything possible in controlling the environment of our oils, that we are keeping inert gas systems in good condition, that breathers are properly applied and maintained, that the oil is dry and that where practicable, we are controlling temperatures, what can the operating man do to follow the oil itself?

We would all like some simple, single test that can be made in the field, but as yet this test has not been devised. We can find advocates for interfacial tension, neutralization number, power factor, steam emulsion, and other supplementary tests, and it is interesting in this connection to review the results of a comprehensive questionnaire of A.S.T.M. of five years ago covering some 70 widely scattered utilities. Of these companies, all 70 list dielectric test, 61 make neutralization number, 39 note color and visual inspection for sludge or sediment, 22 note power factor, 4 mention steam emulsion, and 4 mention interfacial tension.

These 70 companies were asked to rate the tests they made in the order of their importance and of the 70 replies, 64 rate dielectric as No. 1, and to quote from the report on this questionnaire: "beyond the statement of the fact that the dielectric test is generally ranked first, any further attempt to rank the various tests listed as to relative importance appears to resolve itself into an absurdity." It would seem after perusal of the A.S.T.M. report of December 15, 1944, that there are many varieties of what might be termed "one man biased opinions" on the subject of oil maintenance and you can take your choice depending on your own opinion of the seriousness of your own oil situation.

Our company has adopted a middle of the road approach which we feel has kept us free from difficulties due to oil, without going overboard on any one phase of this most complex problem, and our present practices are the results of the cooperative efforts of the electrical operating and the chemical engineering groups.

During and following the N.E.L.A. oil program we obtained a good overall picture of our oil problem, and with the interchangeability agreements, were able to materially simplify our stocks and oil use policy, which, with the advent of paraflow as a pour depressant, is now quite simple.

We now handle only two oils, low pour (—30C and below) and high pour (above—30C, but not above —20C). The low pour point oil is used in any equipment, while the high pour oil is restricted to use in transformers, feeder regulators, and oil filled street lighting constant current regulators. We have had no cases of freezing difficulties since adoption of this practice, whereas we had had several cases of freezing of transformers and of circuit breaker operating difficulties with older high pour oils.

Breaker oils are periodically tested in the field and in addition are checked on order of the maintenance engineer as the result of any abnormal frequency or severity of operation. Oil may be either changed or filtered on regular breaker inspections depending upon its dielectric or appearance as judged by color or carbon content. Breaker oils in general have given little trouble and when low pour oil is kept dry, free of contamination, and checked as required by frequency and severity of fault, or normal current operations, should present no problem.

Our transformer oils are checked periodically in the field for dielectric, and on the routine inspection and testing of the transformer the oil is sampled for testing in the shop or laboratory. The conditions as found in the field in the transformer are recorded, together with the laboratory tests on the oil. Most field inspections

show the condition of the oil as satisfactory, and in these cases where oil tests of dielectric, neutralization number and interfacial tension are satisfactory, no further tests are made. We do find many unusual conditions, however, that require further investigation both as to the transformer and the oil, and which is the cause and which is the effect becomes the problem. In questionable cases it is necessary to analyze all of the electrical tests on the transformer, and both electrical and other tests on the oil to determine where the indicated subnormal condition arises. An appreciation of the limitations of each of such tests as dielectric, neutralization number, power factor, steam emulsion number, and interfacial tension, will point to the use of all of them plus others to decide at times upon the timing of and the type of reconditioning required.

Our territory is, geographically, relatively small and we have centered all our oil storage and reclamation at our Manchester property, except for some small supplies, carried in outlying districts for breaker use and make-up as required. All large quantities of oil are handled to and from the central location in either 550 or 250-gal rectangular tanks, designed for easy handling physically, and for cleaning. Each tank of oil is checked for pour and neutralization number on arrival at the oil house and if the acid is below 0.15, is treated separately as a batch. If the acid is above this value, it is dumped in the appropriate pour point, dirty oil tank and allowed to settle. A considerable benefit is derived from this settling period as could be convincingly demonstrated when these tanks are periodically cleaned. The oil is then pumped from above the tank bottom and percolated through a clay bed which is a home made affair, containing some 3000 lb of $^{6}\%_{0}$ mesh Georgia or Florida clay, and given a final pass through a blotter press and then to the high or low pour, clean storage tanks. Each run on a charge of clay is tested periodically for neutralization number and the run controlled to give a final blended result of not over 0.1 neutralization number.

The present percolation method has been in use for 10 years and was adopted after experimenting with several other processes, as being quite effective and simple to handle under the circumstances associated with our system. We also have centrifuges available at the oil house, used only on extremely wet or dirty oils and blotter presses, which are at times, taken to the field for cleaning dirty breaker oils. We find, however, that outage times of equipment are limited and the trend is to oil changing and treatment at the central plant. At present, we are handling about 200,000 gal yearly, approximately half of which is clay treated.

With the amount of transformer reconditioning we have completed, based on inspections and field tests together with associated oil reclamation, we feel we can now look forward to a time when perhaps internal inspections can be eliminated except as indicated by external tests on the transformer and tests on a sample of the oil. It is our feeling that if a transformer is in the condition in which we know it should be when it goes into service, there should be no occasion to open it and expose it to a lot of hazards except as indicated by tests on the oil and on the windings. Embarking on a maintenance philosophy of this sort presupposes that all the weak spots in older units have been eliminated and that the elements causing difficulty in the past have been corrected.

With the use of oxygen inhibitors which are becoming available, and the intelligent following of all the environment influences on insulation and oil, it is our hope that transformers can be kept in service for long periods of years and then shopped for major overhaul when the work can be done under good conditions which afford the possibility of planned reconditioning and modernization by untanking and careful inspection of all elements of the unit.

Oil maintenance is only one of the elements of the overall problem of keeping electrical equipment in condition for continued satisfactory operation. It need not be a serious problem unless the oil is abused or neglected, and if the electrical operating men will lean upon the chemical group usually associated with any enterprise using considerable quantities of insulating oil, their cooperation can develop relatively simple field procedures to assure reliable operation of equipment utilizing insulating oil.

DISCUSSION

PRESENTED BY

ERIC L. ANDERSON, Electrical Superintendent, Bethlehem Steel Co., Johnstown, Pa.

H. H. MARSH, General Superintendent Substastations and Shops, Duquesne Light Co., Pittsburgh, Pa.

JOHN F. WORDEN, Bethlehem Steel Co., Johnstown, Pa.

Eric L. Anderson: In our plant we are not set up to treat our insulating oils at one central location and have to rely on the use of portable equipment. In discussing the treatment of oils, there certainly appears to be varied opinions as to the relative merits of dielectric tests, neutralization numbers, etc. While I always felt that the dielectric test is the best indication of condition of oil, I am nevertheless interested in neutralization index. In this connection, I would like to know how high a neutralization number can go before the oil is giving trouble and should be replaced. Some people claim that a transformer oil neutralization number of 1 or higher is an indication that the oil is no good and should be replaced or reclaimed, even though there is no apparent indication of trouble and the transformer is carrying its rated load successfully and trouble-free. It is hard to economically justify the replacement of the oils in such a unit. I would appreciate it if Mr. Marsh would comment on the relative values of neutralization numbers and whether he has any ideas which he would care to give on the latest or other types of portable equipment for treating oil.

H. H. Marsh: Neutralization or acid number has been used as a guide to indicate the probable sludge precipitation point and 0.7 has been the popular value above which oil is considered in need of reconditioning.

As Mr. Anderson has said, some oils are known to be well above this value and still give no indication of trouble. I feel that there is no one value that is applicable to all oils—the original treatment during refining may have a material influence on sludge point and as referred to in the paper, highly refined oil is resistant to sludge formation but tends to form high acids, while an oil not so highly refined is less acid forming but sludges rather rapidly. Field inspection and recording of field conditions as found together with various test values will build up a record on which to base judgment better than the adoption of an arbitrary value that may be questionable in the operator's mind.

With regard to portable equipment for smaller batch treatments, there are several on the market but not having used them, I am not sufficiently familiar with their merits to discuss them.

John F. Worden: In this homemade filtering process of yours, how much oil is lost through the clay? If you put 500 gallons in how many gallons do you get out?

H. H. Marsh: If you put 500 gallons of oil into 3000 pounds of clay, you lose a good bit by percentage. We attempt to treat much larger batches than that, however, and our loss is relatively small. But I would not recommend a 3000 pound clay batch treatment for 500 gallons of oil. There are other ways that it can be done more economically, by using smaller batches of clay.

Incidentally, prior to the meeting there were some questions asked about inhibitors, and there are several kinds of inhibitors. We have been progressing rather cautiously on inhibitors, because up to now it has been our understanding that certain types of inhibitors may be damaging rather than beneficial. But it is my understanding, there has been information published recently, on a new inhibitor which shows considerable promise. It is known as DBPC, which is the conventional alphabet designation for a chemical formula something like ditertiary butyl para cresol. I think this is a solid which can be added to oil which should give considerable benefit as far as oxygen absorption and deterioration due to oxidation.

I understand they also put it out in a liquid form where the DBPC is dissolved in a high grade of oil, so you can add it as a liquid.

There are limitations to its use, however. It should not be added to old transformers without thoroughly cleaning them up. It is not a cure-all for everything, you cannot go out with a bucket and throw it in an old transformer and get another 20 years of service from the transformer. I think, however, there are promises in some of the new inhibitors being offered today. We are progressing cautiously because some of them may have bad effects rather than good effects, if you do not know the oil and its history prior to their use.

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Program

1950 AISE CONVENTION and IRON AND STEEL EXPOSITION

CLEVELAND, OHIO

Tuesday, September 26

9:00 am—REGISTRATION—Main Lobby

9:00 am—LADIES REGISTRATION AND HEADQUARTERS—Hotel Statler

9:15 am—BUSINESS MEETING—Ball Room
Conducted by President A. S. Glossbrenner

9:30 am—COMBUSTION SESSION—Club Room B

Chairmen: Edwin C. McDonald, Combustion Engineer, Republic Steel Corp., Corrigan McKinney Works, Cleveland, Ohio.

C. E. Duffy, Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Maryland.

"The Use of the Jet Mill for Combustion Purposes and for the Fine Grinding of Various Materials," by G. M. Croft, Manager, Fuel Equipment Department, Blaw-Knox Co., Pittsburgh, Pa.

"Dust, Fume and Smoke Suppression," by Aubrey J. Grindle, Vice President and Consulting Engineer, Whiting Corp., Harvey, Ill.

"Reduction of Hanging and Slipping in Blast Furnaces by Automatic Control," by Otto J. Leone, Engineer, West Newton, Pa.

9:30 am—ELECTRICAL SESSION—Ball Room

Chairmen: J. H. Franz, Superintendent Fabricating Shops, Carnegie-Illinois Steel Corp., McDonald Works, Youngstown, Ohio.

R. J. Beeswy, Assistant Superintendent, Electric Power and Steam Department, Inland Steel Co., East Chicago, Ind.

"Electroplating Rectifiers," by L. W. Reinken, Chief Engineer, W. Green Electric Co., New York, N. Y.

"Preventive Maintenance of Electric Overhead Cranes," by H. C. Mullings, Assistant Superintendent Maintenance, Electric Division, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Low Inertia D-C Motors for Rolling Mill Drives," by J. Henry Schneider, Section Engineer, D-C Machines, Elliott Co., Ridgway, Pa.

12:00 noon—LADIES LUNCHEON
(Meet at Ladies Headquarters)

2:00 pm—STANDARDIZATION SESSION—Ball Room

Chairmen: L. J. Gould, Chief Engineer of Construction, Bethlehem Steel Co., Bethlehem, Pa.

Eric Anderson, Electrical Superintendent, Bethlehem Steel Co., Johnstown, Pa.

"Standardization Report," by L. J. Gould, Chairman, AISE Standardization Committee.

"Report on Mill Motor Standardization," by M. B. Antrim, Chairman, AISE Mill Motor Committee.

"Progress Report of Carbon Brush Standardization," by E. L. Anderson, Chairman, AISE Carbon Brush Standardization Committee.

"Recommended Plain Bearing Design Practice," by C. E. Pritchard, Chairman, AISE Plain Bearing Committee.

"Progress Report on Wiring Standardization," by J. E. Bodoh and C. G. Dimitt, Co-chairmen, AISE Wiring Committee.

"A Proposed Specification for Hot Metal Ladles," by B. G. Johnston, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa.

2:00 pm—MECHANICAL SESSION—Club Room B

Chairmen: J. J. Healy, Project Engineer, Armco Steel Corp., Middletown, Ohio.

P. L. Walter, Superintendent Mechanical Department, Republic Steel Corp., Canton, Ohio.

"Rolls for Centering and Alining Materials," by E. T. Lorig, Chief-Senior Staff Engineering Bureau, Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

"New Facilities for the Stocking and Shipping of Pipe at Lorain Works of National Tube Company," by C. Clarke Wales, Chief Project Engineer, National Tube Co., Lorain, Ohio.

"Some Aspects of Selecting and Applying Gears for Rolling Mill Equipment," by Edward C. Denne, Consultant and Manager of Gear Dept., United Engineering and Foundry Co., Pittsburgh, Pa.

10:00 pm—EXHIBITORS DANCE—Euclid Ball Room, Hotel Statler

Wednesday, September 27

9:00 am—ROLLING MILL SESSION—Club Room B

Chairmen: D. W. Lloyd, General Superintendent, Youngstown Sheet and Tube Co., Youngstown, Ohio.

C. P. Hammond, Superintendent Rolling Mills, Rotary Electric Steel Co., Detroit, Mich.

"The Design and Use of Tungsten Carbide Rolls for Cold Rolling Metals," by R. T. Beeghly, Vice President and General Manager, Metal Carbides Corp., Youngstown, Ohio.

"The Continuous Seamless Pipe Mill," by John L. Young, Vice President-Engineering, National Tube Co., Pittsburgh, Pa.

"Rolling of Tool Steels," by H. C. Bigge, Superintendent of Tool Steel Div., Bethlehem Steel Co., Bethlehem, Pa.

9:00 am—ELECTRICAL SESSION—Ball Room

Chairmen: K. L. Johannsen, Superintendent, Assigned and Operating Maintenance, Carnegie-Illinois Steel Corp., Duquesne, Pa.

R. W. Graham, Superintendent Electrical Department, Bethlehem Steel Co., Lackawanna, N. Y.

"Transformer Oils in the Steel Plant," by John F. Boal, Lubrication Engineer, Carnegie-Illinois Steel Corp., Homestead, Pa.

"Requirements for a Modern Steel Mill Distribution System," by F. H. Wickline, Construction Electrical Engineer, National Tube Co., Lorain, Ohio.

"Grounding Practice of the Inland Steel Company," by V. E. Schlossberg, Superintendent Electric Power and Steam Departments, Inland Steel Co., East Chicago, Ind.

12:00 noon — LADIES LUNCHEON

1:00 pm—INSPECTION TRIP—National Tube Company, Lorain, Ohio

6:00 pm—OLD TIMERS DINNER

Thursday, September 28

9:00 am—TRAINING SESSION—Ball Room

Chairmen: I. N. Tull, Electrical Superintendent, Republic Steel Corp., Cleveland, Ohio.

John H. Vohr, General Superintendent, Carnegie-Illinois Steel Corp., Gary Works, Gary, Ind.

"Supervisory Development," by A. C. Croft, President, National Foremen's Institute, Inc., New London, Conn.

"The Bethlehem Loop Course," by H. C. Houghton, Assistant to Manager of Personnel, Bethlehem Steel Co., Bethlehem, Pa.

"Motor Inspection Training Programs," by George Kennedy, Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

9:00 am—LUBRICATION SESSION—Club Room A

Chairmen: W. M. Schuck, Lubrication Engineer, Armco Steel Corp., Middletown, Ohio.

R. A. Kraus, General Mechanical Foreman, Republic Steel Corp., Chicago, Illinois.

"What to Look for in Hydraulic Fluids," by Anthony J. Zino, Jr., Assistant Sales Manager, Industrial Division, Swan-Finch Oil Corp., New York, N. Y.

"Rolling Solutions for Specialty Steels," by Maxwell L. Bible, General Foreman, Cold Reduction Div., Crucible Steel Company of America, Midland, Pa.

"Metal Drawing Lubricants for Wire, Tubing and Sheet Steel," by Walter A. Smigel, General Manager and H. Grey Verner, Ph. D., Director of Research, R. H. Miller Co., Inc., Homer, N. Y.

9:00 am—COMBUSTION SESSION—Club Room B

Chairmen: R. A. Lambert, Superintendent, Steam and Combustion, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

E. T. W. Bailey, Chief Combustion Engineer, Steel Company of Canada, Ltd., Hamilton, Ontario, Canada.

"The Public Demands Better Combustion," by L. T. White, Director, Business Research, Cities Service Oil Co., New York, N. Y.

"The Application of the Heat Prover to the Steel Industry," by Joe G. Sparks, Cities Service Oil Co., Chicago, Ill.

"Economics of a 500-Ton Open Hearth Furnace," by Walter W. Kompart, Combustion and Hydraulic Engineer, Weirton Steel Co., Weirton, W. Va.

"Oxygen for the Open Hearth—Its Storage and Distribution," by R. Tietig, Jr., Engineer and B. P. Sarasin, Engineer, A. J. Boynton & Co., Chicago, Ill.

2:00 pm—GENERAL SESSION—Ball Room

Chairmen: A. S. Glossbrenner, Vice-President Operations, Youngstown Sheet and Tube Co., Youngstown, Ohio.

An address by H. B. Jordan, President, American Steel and Wire Co., Cleveland, Ohio.

"Engineering and Purchases," by Thomas D. Jolly, Vice President—Engineering and Purchases, Aluminum Company of America, Pittsburgh, Pa.

"Proposed New England Steel Plant," by Clifford S. Strike, President, F. H. McGraw & Co., New York, N. Y.

7:00 pm—FORMAL DINNER AND DANCE—Grand Ball Room—Hotel Statler

Friday, September 29

9:00 am—OPERATING PRACTICE SESSION—Club Room B

Chairmen: W. H. Collison, Superintendent of Coke Plant, Great Lakes Steel Corp., Ecorse, Detroit, Mich.

Paul E. Thomas, Assistant General Superintendent, Carnegie-Illinois Steel Corp., Gary, Ind.

Density Control of Coal Charged in Coke Ovens," by C. W. Stahl, Engineer, Coal and Coke Chemical Research, Bethlehem Steel Co., Bethlehem, Pa. and J. K. Kurtz, Coke Oven Superintendent, Bethlehem Steel Co., Sparrows Point, Maryland.

"The Use of a Fuel Oil as an Absorption Oil in Recovery of Light Oil from Coke Oven Gas," by C. R. Montgomery, Chief Chemist, By-Product Coke Dept., Pittsburgh Steel Co., Pittsburgh, Pa.

"Blast Furnace Hearth Cooling," by Owen R. Rice, Freyn Engineering Co., Chicago, Ill.

9:00 am—ELECTRICAL SESSION—Ball Room

Chairmen: W. J. Tunny, Superintendent Electrical Maintenance, Youngstown Sheet and Tube Co., East Chicago, Ind.

Malcomb B. Antrim, Superintendent, Electrical Maintenance, Lukens Steel Co., Coatesville, Pa.

"Temper Rolling with Modern Control," by J. F. Sellers, Engineer-in-Charge D-C Design, R. M. Peeples, Engineer and A. C. Halter, Engineer, Control Section, Engineering Department, Allis-Chalmers Manufacturing Co., Milwaukee, Wisconsin.

"Temper Mill Power Requirements," by Wm. P. Smith, Industrial Engineering Divisions, General Electric Co., Schenectady, N. Y., and J. E. Butler, Electrical Engineer, Weirton Steel Co., Weirton, W. Va.

"Acceleration Characteristics of Tandem Cold Reduction Mills, by W. R. Harris, Manager, Metal Working Section, Industry Engineering Department and R. W. Moore, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

2:00 pm—LUBRICATION SESSION—Club Room B

Chairmen: D. E. Whitehead, General Lubrication Engineer, Crucible Steel Co. of America, Pittsburgh, Pa.

N. I. Whiteley, Lubrication Engineer, American Steel and Wire Co., Cleveland, Ohio.

"Graphite as a Lubricant," by E. S. Glauch, Mechanical Engineer, Joseph Dixon Crucible Co., Jersey City, N. J.

"Extreme Pressure Lubricants," by James H. Lewis, Lubrication Engineer, Carnegie-Illinois Steel Corp., Clairton, Pa.

"Laboratory Screening of Multi-Purpose Type Greases for Plant Performance Testing," by E. M. Kipp, Chief, and C. A. Zeiler, Research Engineer, Lubricants Division, Aluminum Research Laboratories, Aluminum Co. of America, New Kensington, Pa.

2:00 pm—OPERATING PRACTICE SESSION—Ball Room

Chairmen: G. C. Brainard, Jr., Assistant Superintendent Cold Strip Mill, Youngstown Sheet and Tube Co., Youngstown, Ohio.

P. E. Haglund, Superintendent, Raw Materials and Semi-Finished, Ford Motor Co., Dearborn, Mich.

"Analyzing Open Hearth Data—Statistics vs. Opinion," by Wade R. Weaver, Director, Steel Conservation and Quality Control, Republic Steel Corp., Cleveland, Ohio.

"Centerless Turning of Bars, Billets and Tubes," by Walter Siegerist, President, The Medart Co., St. Louis, Mo.

"Television in Industry," by J. A. Good, Manager, Electronics Department, Diamond Power Specialty Corp., Lancaster, Ohio.

EXPOSITION AND TECHNICAL SESSIONS are at Cleveland Public Auditorium. SOCIAL FUNCTIONS are at Hotel Statler.

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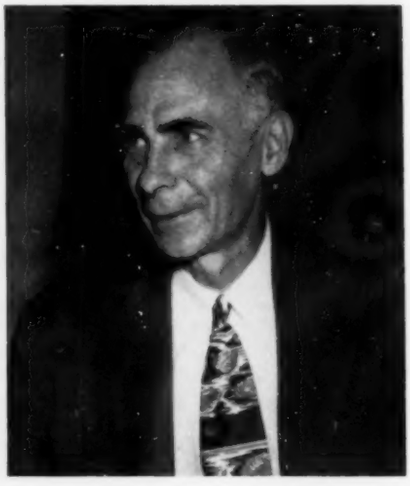

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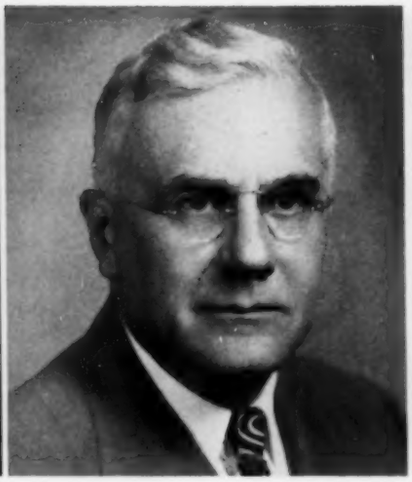

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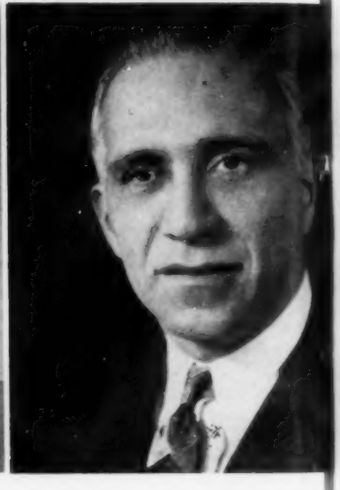

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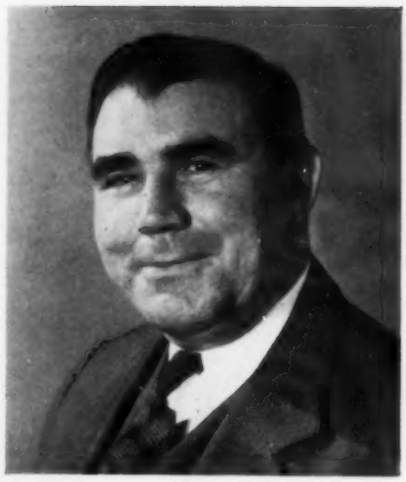

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Abstracts of Papers

To be presented at

AISE ANNUAL CONVENTION

PUBLIC AUDITORIUM

CLEVELAND, OHIO

SEPTEMBER 26, 27, 28 and 29, 1950

DUST, FUME AND SMOKE SUPPRESSION

by AUBERY J. GRINDLE, Vice President and Consulting Engineer, Whiting Corp, Harvey, Ill.

▲ THE problem of dust, fume, and smoke suppression dates back to the year 1257 when Queen Eleanor, wife of Henry the Third, is reported to have left the town of Nottingham, England, because of the smoke from "sea coals." Industry and smoke abatement officials have been struggling with this problem ever since.

As industry expands and the population becomes more concentrated, the problem becomes more serious. It is no longer practical to build an industrial plant out in the open country to keep from being a nuisance to the neighbors, because the plant is soon surrounded with homes, so industry is now installing dust, fume, and smoke corrective equipment on a much greater scale than ever before.

During the past ten years, city, county, and state ordinances controlling the amount of "man-made" contaminants are becoming more and more stringent and being enforced throughout the United States, Canada, and other parts of the world with more sincerity and determination.

The Donora, Pa., smog episode, the serious smog problem of Los Angeles County, and other less serious conditions have created a new urgency for cleaning up the atmosphere, both inside and outside industrial plants and before very long, even the home, automobile, and incinerator will be required to correct their contribution to this nuisance.

Regardless of the amount of truth in the claims of health and agricultural authorities regarding the damage done by man-made impurities, it is conceded that we do have an increasing hazard that requires the cooperation of the offending manufacturing plants, manufacturers of corrective equipment and enforcement agencies in finding an economically feasible solution to the problem.

All industry, especially iron and steel plants, is taking an active interest in cleaning up the atmosphere, and corrective equipment is now being developed at a rapid pace. Collecting the large particulate matter is no longer good enough, we now find that "smog," the combination of smoke and fog is caused by the submicron material that escapes from all kinds of stacks and, therefore, more efficient suppression equipment is required.

In some localities where there are no temperature inversion problems, simple collectors are suitable, but in many localities it is going to be necessary to keep the particulate matter emitted with the stack gases under $\frac{1}{10}$ gr per cu ft at atmospheric temperature, and to burn the carbon monoxide gas to less than one per cent. In some plants and localities the arresting of SO_2 and other fumes will be required.

Corrective equipment now available consists of single and multiple wet and dry type cyclones; venturi scrubbers; wet and dry filters; scrubbers of various designs; cotton, wool, and silicone-treated glass-cloth bag and screen collectors; wet and dry type electrostatic precipitators, and ultrasonic towers.

Efficiencies from 20 to 97 per cent may be obtained depending upon the problem involved and the amount of money available for this type of equipment.

THE USE OF THE JET MILL FOR COMBUSTION PURPOSES AND FOR THE FINE GRINDING OF VARIOUS MATERIALS

by G. M. CROFT, Manager, Fuel Equipment Department, Blaw-Knox Co., Pittsburgh, Pa.

▲ THE paper describes the application of the fluid energy pulverizer to industrial uses. These applications will apply in general to solid fuel combustion and grinding of various materials including chemicals, insecticides, pigments, foods, building materials, etc.

The fluid energy pulverizer by its inherent design uses energy for pulverization from superheated steam or air and from compressed air at atmospheric tem-

perature where necessary due to temperature control conditions. Particle size reduction of the product is obtained by high velocity impingement of particle against particle. This method of pulverization provides a mill which is comparatively low in maintenance due to the fact that the materials being pulverized are ground against themselves rather than any portion of the mill.

The fluid energy pulverizer in the combustion field can be used for the pulverization of any grade of solid fuel regardless of moisture content and grindability factor. Such fuels would include anthracite, bituminous coal (both high and low grades), coke breeze, petroleum coke, lignite, etc. This mill is capable of pulverizing fuels to a fineness considerably in excess of conventional practice and at a lower cost for equivalent pulverization than other types of mills.

The mill is especially applicable to the fine grinding of materials other than solid fuels. The use of a power driven classifier affords precise control in micron sizes, particularly top particle sizes. Other adjustments available in the mill are effective for control of average micron particle sizes. The low maintenance of the mill on abrasive materials results in a minimum of contamination of finished product due to negligible wear of the mill.

REDUCTION OF HANGING AND SLIPPING IN BLAST FURNACES BY AUTOMATIC CONTROL

by OTTO J. LEONE, Engineer, West Newton, Pa.

▲ IN order to keep their furnaces working continuously at increased rates, blast furnace operators are constantly striving to improve furnace regularity. Many investigations have been made to determine the various factors which affect the smooth operation of blast furnaces; these have resulted in improvements that have greatly reduced the effects of furnace irregularities. Furnace lines have been improved to suit new ores and practices; elaborate charging methods have been developed to give better stock distribution; sintering, sizing of materials, blending and other beneficiation of raw materials are practiced; the size, number and arrangement of tuyeres have been changed to give better blast distribution; the humidity, temperature and volume of the blast are controlled—all these improvements have been made to obtain better counter-current gas and material flows and gas-solid contact.

In spite of the many advances that have been made, certain irregularities in furnace operation still are a major problem, mainly because the methods now used do not permit control that is sufficiently flexible or positive to meet all the furnace conditions. Such conditions as "hanging" and "slipping," for example, still present a serious problem. In addition to the bad effects of hanging and slipping on the furnace operation and tonnage output, the ejection of dust and gases from the furnace to the atmosphere by the bleeder valve operation during heavy slips poses a public relations problem, if the blast furnace is located in a residential area. The recent enactment of air pollution laws by industrial centers in which blast furnaces have been cited as contributing to the air polution, has resulted in the formation of special committees to study the problem.

The prevention or reduction of hanging and slipping in blast furnaces by manual or automatic methods seems almost an impossibility at first thought, especially when one considers the many factors which have been attributed as the causes. However, a rational study of the problem shows that all, or nearly all of the factors which may lead to hanging, channeling, and slipping, can be resolved into a "common denominator," in terms of a practical measurable function which can be correlated with all the factors either by cause or effect. In order to be of practical use the "common denominator" must lend itself to easy instrumentation and adaption to the furnace system, any change in the furnace conditions which may lead to hanging or slipping will be detected in the initial stages, so that by automatically applying proper corrective action to one or more of various furnace conditions, hanging and slipping may be practically eliminated, assuming that the usual care and practice are used in operating the furnace.

The paper discusses factors leading to hanging, channeling and slipping and from the theory will develop the logical selection of instrumentation to detect and to correct furnace irregularities in accordance with the theory. A new method of furnace control will be described which gages the changes in "buoyant effect" of the stock charge in the shaft, by a measurement of the changes in the resistance of the furnace charge voids to the flow of furnace gases. A top gas pressure instrument is also interlocked with the control system to ensure proper corrective action under all conditions.

The operating results to date on an actual installation that has been in successful operation at the Pittsburgh Coke & Chemical Co.'s blast furnace at Neville Island, Pa., are described in the paper. The installation at this plant not only improved the furnace operation, but also solved an air pollution problem by eliminating bleeder operation. A schematic diagram of the control method is shown, which includes control valves in the cold blast line and in the gas discharge line leaving the furnace. The operation of the controller under certain conditions as after a cast, or during periods of increasing humidity, is mentioned.

Several modes of operation are discussed. Charts will be shown to demonstrate the fast effectiveness of the control method as a "short time" corrective measure on a furnace that has been hanging, to start the furnace moving. The advantages of this method over "long time" corrections such as changing burden ratios, and charging extra coke charges or scrap are covered.

ELECTROPLATING RECTIFIERS

by L. W. REINKEN, Chief Engineer, W. Green Electric Co., New York, N. Y.

▲ THIS paper deals with metallic rectifier power supplies for electroplating and other applications requiring d-c potentials from a few volts up to 50 volts and from

a few amperes up to an unlimited value. Topics discussed include:

1. Brief review of use of electroplating rectifiers in this country.
2. Different types of metal rectifiers, copper oxide, copper sulphide, and selenium.
3. Advantages of metal rectifiers.
4. Disadvantages of metal rectifiers.
5. Installation, maintenance, and protection.
6. Information needed for rectifier equipment design.
7. Analyzing rectifier specifications and proposals.

PREVENTIVE MAINTENANCE OF ELECTRIC OVERHEAD CRANES

by H. C. MULLINGS, Assistant Superintendent Maintenance, Electric Division, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

▲ IT is becoming a matter of common knowledge that a preventive maintenance program consists essentially of having available, the necessary parts and trained manpower to make anticipated repairs with a minimum loss of production and at a minimum cost. However, an adequate preventive maintenance program starts with the proper co-operation between the various engineering and operating departments in an effort to incorporate adequate features of design, engineering and construction in the cranes and runways.

After the installation of the necessary crane facilities, an adequate inspection routine must be established and religiously followed. Crane operating personnel and supervision must also be trained in the proper operation of the cranes in order to provide a well integrated preventive maintenance program.

Since the use of overhead cranes is so finely interwoven in almost every phase of steel plant operations, these various features of an adequate preventive maintenance program as summarized, constitute the type of a preventive maintenance program toward which we should strive. This is especially true in these times of constantly increasing costs when repair time and down time are expensive items.

This paper presents some of the various factors which are considered essential in formulating an adequate preventive maintenance program.

LOW INERTIA D-C MOTORS FOR ROLLING MILL DRIVES

by J. HENRY SCHNEIDER, Section Engineer, D-C Machines, Elliott Co., Ridgway, Pa.

▲ THE low inertia d-c motor has low inertia as compared to a d-c motor with normal proportions.

They are used when short acceleration time and short deceleration time are required. Most of the mills that handle metal strip in coils require quick acceleration and deceleration to reduce the amount of off-gage material and to increase production. The highest speed mills require the lowest inertia motors.

The low inertia is obtained by using a smaller diameter armature with a much longer core. The weight remains approximately the same but the radius of gyration is decreased. Commutation, ventilation, and mechanical considerations determine the minimum diameter for a given rating. Separate pressure ventilation is required to cool these machines. These long core, small diameter machines cost more to manufacture than motors with normal proportions.

The inertia can be made still lower by using two, three or four low inertia motors to supply the total power required by the mill or reels. These may be arranged as twin drives, tandem drives or twin tandem drives. Two, three, or four motors are more expensive than one large motor of the same total horsepower.

Sometimes it is possible to reduce the accelerating time by using lower speed motors. These slower motors may have more WK^2 but will have less stored energy due to rotation and hence will be easier to start and stop.

NEW FACILITIES FOR THE STOCKING AND SHIPPING OF PIPE AT LORAIN WORKS OF NATIONAL TUBE COMPANY

by C. CLARKE WALES, Chief Project Engineer, National Tube Co., Lorain, Ohio.

▲ EXPANSION in facilities have been provided at the Lorain works for the assembly, stocking and preparation for shipment to the customer of the final products which are produced in this plant. The new warehouse contains many features which, singly are not entirely new, have been combined in a rather unusual manner and with outstanding results. One of the problems which must be solved in such a warehouse comes as a result of changes in marketing practices, which have resulted in a demand for pipe in mixed carloads containing as many as 50 items in a wide range of sizes.

The new warehouse has an operating capacity to store 40,000 tons of pipe in sizes 4 in. and under, including about 300 items. Maximum storage capacity is 60,000 tons with all racks full. Trackage has been so arranged that the pipe finished in any mill can be spotted in the warehouse opposite any required stocking area. Six standard design racks are used for the storage of the pipe. The result of the efficient layout has enabled handling and shipping in mixed carload lots over a monthly period at an average rate of 60 cars per 24-hr day by a normal crew consisting of 24 men per turn. All switching is done by one 50-ton diesel-electric locomotive. In addition an average of 30 truck loads of pipe are shipped every 24 hours.

ROLLS FOR CENTERING AND ALINING MATERIALS

by E. T. LORIG, Chief-Senior Staff Engineering Bureau, Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

▲ EVER since the development of continuous wide hot and cold strip rolling of light gages some thirty odd years ago, the proper tracking of such wide flat metal strip over deflector rolls and pulleys in subsequent

processing lines has presented problems in guiding which have never been fully and adequately solved.

Conveyor and power transmission belts of flat steel, which are known to be more highly efficient than other materials now being used for such purposes, have lost favor for possible use in many desirable applications only because of the tracking or guiding difficulties encountered in the past under desirable and reasonably low strip tensions which, up to the present time at least, could not be used.

Numerous auxiliary guiding mechanisms such as power actuated tilting or shifting rolls together with high strip tensions, free hanging loops in conjunction with strip edge guides, etc., are presently being used to correct cumulative lateral weave which occurs as the strip is forwarded over the rolls or pulleys.

The comparatively recent advent of larger coils, longer strip, higher processing line speeds, more lengthy processing lines, and longer belt conveyors has in total aggravated metal strip guiding and tracking difficulties materially. Auxiliary guiding devices and permissible high strip tensions have now become less and less fool proof in securing good continuous tracking, indicating that something radical had to be done to metal strip processing lines and belted arrangements to improve tracking, reduce strip tensions to values within reason and relieve edge damage.

A study of the planar action of conventional deflector and conveyor rolls and pulleys under rotation, together with the planar action of the strip materials in contact being conveyed or forwarded over them was undertaken by the engineering division of the Carnegie-Illinois Steel Corp. to determine the causes of erratic tracking and lateral weave with a view toward improving guiding, reducing detrimental high strip tensions and eliminating strip edge damage, if at all possible.

This study included experimental work with motor driven models of various roll or pulley equipped applications or systems. The results of this study indicated that conventional solid bodied rolls, cylindrical or crowned, were devoid of centering ability of metal strip or metal belts under reasonable and permissible strip tensions and, therefore, not suitable for tracking high modulus of elasticity materials such as continuously rolled flat light gage steel or other metals.

The natural laws governing the tracking of low moduli materials over crowned rolls or pulleys such as rubber, composition and leather belting, textiles, etc., do not and cannot apply to metals and paper. For example, they do not apply where permissible tensions in processing do not provide sufficient resilience in these latter materials within their respective elastic limits to permit both longitudinal and lateral temporary deformation simultaneously, which inherent ability is necessary to effect tracking over conventional crowned rolls or pulleys.

This study led to the development of the split rolls and pulleys now recognized as automatic self-centering rolls, and this is the subject of this paper. These rolls, unlike solid bodied cylindrical or crowned conventional rolls, have in themselves the ability to naturally center and aline metal and paper strip like products being conveyed or forwarded over them under much lower strip tensions, in an improved manner, such that edge contact guides and other auxiliary guide mechanisms can, in most instances, be entirely eliminated.

If edge guides are necessary in some cases, which should be rare, with the automatic self centering rolls or pulleys as developed, then the pressures of such guides against the strip regardless of width, will be reduced to a degree such that no damage to the strip edges can readily occur.

With closed circuits, represented by metallic belts which make repetitive cycles in operation, extremely low belt tensions can be utilized if desired, and accurate tracking can be secured without resorting to auxiliary belt guiding means when automatic self centering pulleys as developed are utilized.

While automatic centering rolls were fundamentally developed for more naturally tracking and alining metallic strip and belts under strip tensions very much lower than now utilized and required, yet the rolls are equally effective in many other types of equipment and in many industries unrelated to the manufacture of metals.

There are at present several processing installations in satisfactory operation within the steel producing industry which employ automatic centering rolls to assist in tracking, centering and alining flat strip and coils. Other installations are currently being built and many others contemplated.

SOME ASPECTS OF SELECTING AND APPLYING GEARS FOR ROLLING MILL EQUIPMENT

by EDWARD C. DENNE, Consultant and Manager of Gear Dept., United Engineering and Foundry Co., Pittsburgh, Pa.

▲ THE factors influencing the selection and application of gears for rolling mill equipment are not as intricate and mysterious as many are led to believe. Too many times the supposed faulty gear is only considered, not weighing the many extraneous conditions causing the trouble.

There is no such gear as an all purpose gear. The many variables entering into the selection must first be recognized before the type and final gear details can be established for its economical and satisfactory operation.

There are many antiquated equipment installations operating today, some requiring constant maintenance. In addition to the cost of frequent replacements of the gears, there is the costly production "down time." This situation is not so frequent in standard reducers, or main mill drives, since they are designed and built as units integrating most of the many variables. However, there are times when competition and the resulting hair line selections have caused maintenance and production forces to constantly baby a drive.

When a drive is purchased on the basis of price only, and no consideration is given to the extras built into the design, such as liberal bearings, shafts, gear elements, rigid housing, quality of machine work, cutting facilities, responsibility, etc., the buyer is accepting same on such a basis. It is the purchaser's responsibility to ascertain his needs, to specify them adequately and to assure himself that the specifications

have been met to satisfactorily do the job. This means that the engineer will be the criticised person for not correctly advising his purchasing department.

All have had experience at one time or another with a set of gears that would actually wear out without performing any useful service. Yet very little is done to ascertain the real cause. Much of our present day gear troubles can be traced to copying antiquated practices, instead of employing up to date improved methods of design and manufacture.

THE DESIGN AND USE OF TUNGSTEN CARBIDE ROLLS FOR COLD ROLLING METALS

by R. T. BEEGHLY, Vice President and General Manager, Metal Carbides Corp., Youngstown, Ohio.

▲ A wider use is being made of tungsten carbide rolls for cold rolling all types and analyses of strip steel and non-ferrous metals. Over 50 plants now have carbide rolls installed on 2-high, 3-high, 4-high and cluster type mills. Tungsten carbide rolls are produced by hot pressing a mixture of extremely fine powdered tungsten, cobalt and carbon in a graphite mold. The metal powder is compressed under heat and pressure to one-third its original length which produces a structure of unusual density. Carbide rolls have a density of 14.8 compared to 8.6 for steel. Other physical properties include a value of 275,000 psi transverse rupture strength, a tensile strength of 150,000 psi, and a Rockwell "A" hardness of 92 (equivalent to 120 Scleroscope). Finish grinding is accomplished with diamond bonded wheels which impart an extremely brilliant and lustrous surface finish to the roll face. Profilometer tests indicate a surface variation of less than 0.0000003 in.

Solid carbide rolls, similar in design to steel rolls, are used for rolling strip wider than ½ in. Nickel steel arbors with carbide sleeves are used for rolling flat or shape wire, metal tinsel and ribbon. Sleeve-type rolls are water cooled internally. The low thermal expansion properties of carbide rolls make it possible to roll flat and shape wire to tolerances of 0.0001 in.

Carbide rolls are used as either idle or driven rolls, the torsion strength being superior to carbon steels and only slightly inferior to alloy steels. Rolls in diameters up to 24 in. and lengths up to 40 in. can be produced with existing equipment, the largest weighing in excess of 1,000 lb.

Rolling speeds, amount of reduction, annealing cycle, roll shape and other operating procedure closely follows established practice with steel rolls with minor variations. However, speeds up to double normal practice can be used without affecting roll life. Reductions per pass from 10 to 20 per cent greater than standard can be taken with less power being required than with steel rolls. A 95,000,000 psi modulus of elasticity value, three times that of steel rolls, makes possible the production of bright finish strip having twice the flatness and smoothness of steel rolled strip. Only ⅓ to ½ the normal amount of tin, copper or other plating material is required to plate carbide rolled steel. The edges of steel punches and dies last twice as long when stamping carbide rolled steel. The combination of a 750,000 psi compressive strength and extremely hard structure gives carbide rolls long life—outlasting steel rolls 50 times on low carbon steel and 25 times on hard alloys and stainless.

Extreme care is needed in installing carbide rolls to avoid misalinement. They should not be installed after taking initial passes with steel rolls. Best results are obtained using carbide rolls through entire rolling cycle. A rolling oil with more body and film strength is required because reduction is accomplished over a smaller area of contact as carbide rolls do not flatten out. On dry grinding, carbide rolls hold their polish 10 to 15 times longer than steel rolls.

No crown is required to compensate for deflection. Carbide rolls are occasionally hollow ground from 0.0002 to 0.002 in. Maintenance costs are less because they require fewer regrinds. Normally only 0.0005 in. is removed per grind compared to 0.002 in. for steel rolls. Rolling mill manufacturers are now building mills designed to accommodate carbide rolls.

THE CONTINUOUS SEAMLESS PIPE MILL

by JOHN L. YOUNG, Vice President-Engineering, National Tube Co., Pittsburgh, Pa.

▲ THE application of the continuous principle to the new seamless mill permits production of seamless pipe in multiple lengths and at substantially constant tonnage regardless of diameter or wall thickness.

The new mill at Lorain Works has a rated capacity of 18,000 tons per month, in pipe sizes 2 to 4 in. Two inch pipe delivers from the 12-stand tension reducing mill in 142-ft lengths at a speed of 1300 fpm.

Only one size of round billet is employed regardless of the final diameter of the finished product and mill operation is almost completely automatic. Uniformly heated billets from the 80-ft rotary hearth furnace rotate as they are delivered to the piercing mill. The pierced billet is then conveyed to the inlet of the 9-stand continuous rolling mill where the outside diameter and wall thickness are reduced and the length of the pierced billet is extended to a maximum of 70 ft. The rolled tube, now approximately 5 in. outside diameter, and the mandrel are then conveyed to the stripper where the mandrel is withdrawn and the rolled tube is delivered to the reheating furnace. After being reheated, the rolled tube passes either through the 12-stand tension reducing mill where large diameter reductions are made while maintaining or reducing wall thickness, or the 12-stand sizing mill where moderate diameter reductions are made to bring the pipe to final size. This provision permits size changes to be made without loss in operating time.

From the cooling tables the tubes are delivered to the rotary straighteners and thence to the automatic cut-off machines where they are cut to the desired length and cradled. Between the cut-off machines and the finishing floor, stock racks are provided.

The finishing floor consists of three lines. Two of these lines are equipped with facing and chamfering units, threading units, automatic coupling screwing-on

units and automatic hydrostatic testing units to accommodate lengths to 50 ft. The third unit, having no threading or coupling screwing-on machines, will accommodate pipe up to 65 ft long. All units are equipped with dual heads with a finishing rate of 420 pieces an hour on 2 in. pipe.

No. 4 continuous seamless pipe mill was placed in operation in January, 1949. A similar but somewhat smaller continuous seamless mill began operations at the Gary works in March of the same year.

TRANSFORMER OILS IN THE STEEL PLANT

by JOHN F. BOAL, Lubrication Engineer, Carnegie-Illinois Steel Corp., Homestead, Pa.

▲ TRANSFORMERS are a vital part of the electrical equipment in the present day steel plant. A problem of concern to many steel plant operators is the maintenance of the insulating oil in their transformers in a suitable condition for long trouble free operation of the equipment.

In the average steel plant the transformers may vary greatly in age and design, the older types offering little protection to the oil from oxidation by the atmosphere, while many of the newer transformers include features which restrict or entirely eliminate the contact between air and oil, thereby increasing the useful oil life.

As a preventive maintenance measure, various power companies and other industries, including some steel plants, have adopted a regular maintenance program for keeping their transformer oil in good condition. A complete program should include periodic sampling and testing of the used oil in each transformer and reconditioning of the oil by a suitable means, where tests indicate this is necessary. The various tests made on used oils and their significance are discussed together with the various types of reconditioning equipment available. A well kept record of the periodic tests made on each transformer is important.

A development of increasing interest to operators of transformers is the use of oxidation inhibitors which may be added to the transformer oil to reduce the rate of oxidation and extend the useful oil life.

By adopting a regular testing and reconditioning program for their transformer oils, steel plants can keep the oil in good operating condition which should result in a decrease in transformer difficulties and overall maintenance and operating costs.

REQUIREMENTS FOR A MODERN STEEL MILL DISTRIBUTION SYSTEM

by F. H. WICKLINE, Construction Electrical Engineer, National Tube Co., Lorain, Ohio.

▲ THE paper uses the new Lorain 60-cycle distribution system as an example in establishing the requirements for an adequate steel mill distribution system. Modern steel mill distribution systems must be planned for load growth and system flexibility over an extremely long life span.

To provide this flexibility and to provide the optimum of service continuity, careful thought must be given to future needs, and to the economic balance between capital investment and production loss resulting from system failure.

Physically, the system must be designed to provide a maximum of protection from lightning phenomena and mill ducts, maximum personnel safety and a minimum of land surface interference.

Distribution voltage should be as high as possible, but not exceed the design range of the large a-c drives to be served. Neither should it exceed the maximum design voltage of compact indoor metalclad switchgear, in order that switchyard space and expensive high voltage switching equipment not be required at the receiving end of the lines.

Underground cable systems operating at 13.8 kv meet more of these requirements than any other system, consequently such a system was selected to serve the new Lorain mills. The underground duct banks were formed by means of pre-cast concrete spacers and fiber ducts, poured in pea-gravel concrete. Prefabricated modular form sections were used for forming, resulting in a substantial saving for formwork. Type H sectored 15-kv paper insulated lead covered cable was used, with 25-kv potheads.

It was necessary, because of building obstructions to install one section of aerial open wire line. It is important to note that during the months that the system has been in operation, the only line failures which have occurred, have been on this open wire section, indicating the superiority of underground cables over open wire lines for mill distribution systems.

GROUNDING PRACTICE OF THE INLAND STEEL COMPANY

by V. E. SCHLOSSBERG, Superintendent Electric Power and Steam Departments, Inland Steel Co., East Chicago, Ind.

▲ REFERENCE in this paper is made to the National Electric Code, Article 250 and steps or moves that were taken at the Inland Steel Co. to make their power system as near lightning proof as possible.

The writer deals with the initial ground; grounding of all equipment including auxiliary equipment, lightning, office equipment, portable equipment and equipment in hazardous locations.

When the electrical equipment was first installed there was some trouble with lightning. Putting lightning arresters at the base of each motor eliminated troubles on the original 2300-v, 25-cycle system. These are also installed on the 6600-v system which was later used on the hot strip mill. When the use of capacitors as well as lightning arresters became the recommended practice these were also installed. A ground wire was also installed over the feeders and this effectively prevented lightning trouble when the ground wire was grounded at each tower. Grounds are sunk in such a way that the ground resistance is less than two ohms. By following out the measures described in the paper as well as the practices recommended by the National Electric Code, the grounding practice has reduced markedly the disturbances in the electrical system.

SUPERVISORY DEVELOPMENT

by A. C. CROFT, President, National Foremen's Institute, Inc., New London, Conn.

▲ ATTEMPTS at improvement never cease with respect to methods, machines and equipment. A similar need for improvement exists with respect to industry's most important production factor: the foreman and supervisor. The need for supervisory development is never satisfied. It is a threefold need, relating to the foreman's position as a production expert, to his obligation as a management representative, and to his function as a leader of men.

This threefold development need has come to be accepted by many companies as a continuing and many-sided program. Although details vary with requirements, one basic approach to supervisory development is now recognized as having the best chances for success. This is the approach of letting foremen and supervisors participate in both the diagnosis of problems and the finding of solutions. Implicit in this approach is the belief that self-improvement and cooperation depend largely on the extent to which foremen are allowed to share in the understanding of problems and to take part in the discussion of remedies.

The content of supervisory development programs should be determined primarily by what the foremen themselves want to know and to learn. It is the self-generated interest to learn, not outside compulsion or persuasion, which guarantees self-improvement. This motivation from within, when channeled by educational leadership, can be depended upon to lead toward the goals desired by management.

If foremen participation in the decisions that affect their operations is the best method of developing and improving the quality of supervision, that participation leads to still another advantage. It effectively destroys the isolation in which foremen usually find themselves. It makes them a functioning part of management.

THE BETHLEHEM LOOP COURSE

by H. C. HOUGHTON, Assistant to Manager of Personnel, Bethlehem Steel Co., Bethlehem, Pa.

▲ BETHLEHEM Steel Co. is an integrated steel company, engaged in iron and steel production from the mine to the finished product. College graduates have an increasingly important place in the present and future organization and activities of the company. The loop course, which was inaugurated in 1922, provides college-graduate personnel to all phases of Bethlehem's activities. It had its beginning in a practice of the sales department of the company, which each year employed a small group of college graduates for training in sales work. Over the years, the program has been developed to its present form, involving three phases of training: (1) basic orientation, (2) specialized training to equip the individual to enter a particular field, and (3) actual on-the-job training.

Training through the loop course is accomplished by a regular series of addresses by top officials of the company at the home office, scheduled plant departmental visits and instruction, motion pictures and other training procedures prior to the actual performance of on-the-job training.

Each of the approximately 1,700 college graduates enrolled in the course since 1922 have been regularly followed up and rated in reports to top management.

The 1950 loop course group is made up of 104 graduates from 41 colleges located in 20 states, from Maine to California. They have now been assigned to the various divisions of the company, including the steel division, sales, mining, shipbuilding, traffic and industrial and public relations.

THE PUBLIC DEMANDS BETTER COMBUSTION

by L. T. WHITE, Director, Business Research, Cities Service Oil Co., New York, N. Y.

▲ THE public demands better combustion. Smog in Los Angeles, disaster in Donora, vanishing stockings in Jacksonville have aroused the American public to the point of demanding better industrial combustion.

In many communities organizations are being formed for smoke abatement and the elimination of air pollution.

An important aspect of industry's public relations is to improve combustion so that the public has no cause for complaint and welcomes industries' atmosphere as well as it does its payroll. One method in which this can be achieved is discussed in Mr. J. G. Sparks' paper.

METAL DRAWING LUBRICANTS FOR WIRE, TUBING AND SHEET STEEL

by WALTER A. SMIGEL, General Manager and H. GREY VERNER, Ph. D., Director of Research, R. H. Miller Co., Inc., Homer, N. Y.

▲ IN this article modern methods in the cold-drawing of steel are considered, with particular emphasis on the role played by lubricants. The article is prefaced by a short theoretical discussion of metal-drawing. Fluid-film type and boundary type lubricants are briefly contrasted. The paper summarizes current practices in the use of lubricants for wire-drawing, tube-drawing and deep-drawing. Dry wire-drawing lubricants are first classified chemically and then considered from the standpoint of their physical properties. This section also includes a discussion of the use of chemical undercoatings which are applied prior to the lubricant. The important factors to be considered in the selection of the proper lubricant for dry wire-drawing include the composition of the metal being drawn, the treatment prior to drawing, the conditions under which the metal forming takes place, and the subsequent operations to be done on the finished wire. Wet wire lubrication is separated into aqueous and non-aqueous subdivisions.

For obtaining special finishes, grease wire drawing is employed. In each category consideration is given to the physical and chemical properties which make for an efficient lubricant. Tube drawing lubricants and lubricants used for deep-drawing are given an analogous treatment involving consideration of both undercoatings and lubricants. Description is given of control tests employed in the tube-drawing field which insure maximum efficiency in the use of a lubricant and optimum results with regard to quality of product. The paper includes practical suggestions to be followed in choosing a satisfactory lubricant and mention is made of certain special lubricants and recent developments in the metal-working field.

WHAT TO LOOK FOR IN HYDRAULIC FLUIDS

by ANTHONY J. ZINO, JR., Assistant Sales Manager, Industrial Division, Swan-Finch Oil Corp., New York, N. Y.

▲ THIS paper is an original treatise on the application of petroleum oils—as hydraulic fluids—in industrial hydraulically-operated or controlled equipment. It describes the physical properties of petroleum oils and their true importance in the operation and maintenance of hydraulic equipment. A direct comparison is made between the usual oil "specs" as written today by the hydraulic engineer or oil supplier, and the actual service performance characteristic or service properties required of the hydraulic fluid. Service properties are listed in the order of their importance in the following chart:

Usual Specifications

1. Gravity, A.P.I.
2. Viscosity, S.U.S.
3. Viscosity index.
4. Flash point.
5. Fire point.
6. Neutralization number.
7. Carbon residue.
8. Color, N.P.A.
9. Pour point.

Service Properties

1. Viscosity.
2. Viscosity index.
3. Demulsibility.
4. Oxidation stability.
5. Lubricating value.
6. Rust and corrosion preventive qualities.

A very comprehensive and illustrated description is given of each service property, its importance in hydraulic operation, method of evaluation, and problems and their correction.

THE APPLICATION OF THE HEAT PROVER TO THE STEEL INDUSTRY

by JOE G. SPARKS, Cities Service Oil Co., Chicago, Ill.

▲ A general outline about the uses and results to be obtained with the heat prover is discussed in respect to its uses throughout the steel industry.

A complete break-down of the heat prover is shown in illustrations. Also covered are results obtained on blast furnaces, operation and economies involved. The same procedure applies to open hearths, soaking pits, reheating furnaces and heat treating units.

ECONOMICS OF A 500-TON OPEN HEARTH FURNACE

by WALTER W. KOMPART, Combustion and Hydraulic Engineer, Weirton Steel Co., Weirton, W. Va.

▲ IN order to increase steelmaking capacity and to reduce the costs of making steel in the open hearth operation, it was decided that the No. 1 open hearth furnace (which is located adjacent to two 25-ton bessemers) be rebuilt on its regular rebuild schedule to accommodate 500-ton heats. This furnace was subsequently rebuilt, starting June 1, 1949 and was put back into operation September 12, 1949. The first two heats made on this furnace were completed in 24 hours and had a tonnage of 530 tons per heat.

Since this time larger ladles have been provided, and the maximum tonnage tapped for a heat to date was 601 tons. These heats are tapped by means of a double trough which pour into either of two ladles. This arrangement is standard on all furnaces rated 400 tons and larger. Heats are now made in eleven to thirteen hours, and faster heats are possible with improved charging practice.

Three roof campaigns have been completed since putting this furnace in operation. The first campaign had a roof life of 116 heats, the second 193 heats and the third roof was replaced after 123 heats. This roof had been damaged in the front section due to charging scrap and it was felt advisable to replace it at this time.

This furnace normally uses 65 per cent blown metal from the two converters mentioned previously, and 35 per cent scrap. Repair costs are low due to basic ends, and the outage time has been reduced.

This furnace was rebuilt with basic ends. The uptakes are of the single construction, as well as the fantail from the slag pocket to a single checker chamber. The port roofs are of basic construction and the balance of the furnace roof is of silica. Seven doors are used on this furnace with basic front walls.

In order to provide sufficient checker capacity, a single checker was used instead of the conventional gas and air checker. The furnace is fired with fuel oil or tar residue. A 600-hp waste heat boiler was installed on the original furnace as an auxiliary. This installation which was made in 1920 was condemned by the insurance company and we were required to take measures to replace or remove this boiler.

In order not to delay the rebuilding of this furnace and also due to the cost of a waste heat boiler, it was decided to equip this furnace with a control system. This system consists of an induced draft fan, forced draft fan, furnace pressure control and a manual inlet vane control on the forced draft fan. No other controls except metering of the fuel is provided.

Our aim in designing this rebuilt furnace was to provide more available draft, fuel and air than it was expected to be used at any time during the operation of the furnace. This has been accomplished and we believe it has been instrumental in reducing the fuel required, as well as showing a saving on refractories.

OXYGEN FOR THE OPEN HEARTH — ITS STORAGE AND DISTRIBUTION

by R. TIETIG, JR., Engineer and B. P. SARASIN, Engineer, A. J. Boynton & Co., Chicago, Ill.

▲ INVESTIGATIONS by various open hearth steel producers during the past four years have shown that in certain instances the installation of a plant to supply oxygen to the open hearth department is economically desirable. Since oxygen is generated at a relatively constant rate while its rate of use in the open hearth furnaces is highly variable, a correctly designed storage and distribution system is necessary. This paper discusses in some detail the design features of such a system and covers the following aspects of the problem:

1. Preliminary design data.
2. Demand for oxygen.
3. Method of producing oxygen.
4. Storage.
5. Compression units.
6. Piping.
7. Instrumentation and controls.
8. Safety.
9. Other uses for oxygen.

In this discussion particular emphasis is placed on the method for sizing the generation equipment and the storage system, and also on the selection of the most suitable storage and compression units.

The paper contains line diagrams of various storage and distribution systems that might be employed, as well as appropriate tables and charts.

ENGINEERING AND PURCHASES

by THOMAS D. JOLLY, Vice President—Engineering and Purchases, Aluminum Company of America, Pittsburgh, Pa.

▲ THE purpose of engineering is to eliminate waste—waste of time, power, minerals, labor, equipment, materials.

The duty of the purchasing agent is to prevent waste of his company's money. Thus both engineers and purchasers have the common goal of eliminating all possible waste. While their procedures are different, there are several fields where they can join forces in seeking this goal.

Since 1900, improved engineering has made it possible for us to raise our real standard of living by almost 70 per cent while we have shortened our working week by an average 18 hours. But since 1940 we have been paying ourselves higher wages than our increase in production has warranted. Engineers and purchasers must combine their efforts to offset cost increases through increased mechanization, better purchasing and elimination of waste.

We can assume, in a given company situation, that the engineers have studied all the usual factors and that the purchasing department is supplying the usual materials at the best possible price. But has an item-by-item study of the materials actually been made? Or are they being supplied in accordance with tradition or personal prejudice?

Many special items now in use are not as good as standard items, and they cost more. Only a careful study of each item used or carried in stock will disclose the waste caused by such buying. Most companies, even those that have been doing a good inventory control job, can reduce inventories 20 to 30 per cent by making such a study and by cataloging the stores to be carried.

Thus standardization is one answer to national and individual company need for cutting costs—standardization in ways of making things, doing things and buying things.

Practically all our technical societies and trade associations now have active committees on standards. Of these, 101 have joined in support of the American Standards Association, in order to coordinate the efforts of all towards standards which will be acceptable to all. The American Standards Association is the clearinghouse for carrying out this standards coordination on the national and international level. ASA provides the machinery through which voluntary standards, as opposed to compulsory standards, are approved. More than 2000 companies, through membership affiliation in ASA, subscribe nearly half a million dollars annually to maintain this arm of free enterprise economy in the public interest.

Properly carried out on a cooperative basis, standards are an invaluable management technique. They are a stimulant to sales, a means of economical production, and the sure, quick way to efficient and economical purchasing.

DENSITY CONTROL OF COAL CHARGED IN COKE OVENS

by C. W. STAHL, Engineer, Coal and Coke Chemical Research, Bethlehem Steel Co., Bethlehem, Pa. and J. K. KURTZ, Coke Oven Superintendent, Bethlehem Steel Co., Sparrows Point, Md.

▲ FINER pulverization of coal to improve the physical properties of coke produces a lower charge density and thus reduces the capacity of the ovens. To regain this lost tonnage, the density of the coal charge obviously has to be increased. This can be done by the addition of oil and water after blending and before pulverization.

However, the main problem is to develop a system where the addition of oil and water can be closely controlled to give uniform density. This controlled density would also insure improved coke quality and the protection of oven walls by eliminating excessively high density charges.

The major factors in successful bulk density control are:

1. Meter controlled apparatus for the addition of water and oil.
2. The quality of the oil used.
3. Supervision. Sweep samples of the treated pulverized coal are taken from the belt at regular intervals and standard A.S.T.M. tests for bulk density made to determine what adjustments should be made to the water and oil additions.

Evidence of the degree of success attained can be realized from one example taken from the tests which will be tabulated in the paper. A thirty-day period shows a maximum density variation of only 43.5 to 44.5 lb per cu ft in the coal charged, whereas the amount of water added varied by 120 per cent and the oil added

during this period ranged from 0.009 to 0.276 gal of oil per ton of coal charged.

The paper includes a flow sheet and description of the apparatus installed, details of control, the importance of selecting the proper grade of oil, and tables of the results.

THE USE OF A FUEL OIL AS AN ABSORPTION OIL IN RECOVERY OF LIGHT OIL FROM COKE OVEN GAS

by C. R. MONTGOMERY, Chief Chemist, By-Product Coke Dept., Pittsburgh Steel Co., Pittsburgh, Pa.

▲ FOR many years operators in recovering light oil from coke oven gas have used a special high boiling petroleum oil meeting rather close specification as an absorbent oil. There have been many discussions as to just what properties a good absorbent oil should have and out of these varied discussions grew a more or less standard set of specifications which are now in use by most purchasers of this type of oil. It is not the purpose of this paper to attack or discuss at length these specifications, as certainly they have fulfilled their purpose, namely, that of removing any possible doubt from the mind of the operator that if trouble was encountered in his wash oil system that this was not primarily due to the type of oil he was using. If recovery or yields dropped, it would be due to temperature, length of contact, poor debenzolization, or some such operating problem, not to a poor absorbent oil which was decomposing, flashing off, gumming up unduly, etc.

Money saved in operations is money earned. If it is possible to substitute a cheaper material in a process without impairing recovery or quality of product and, most important, without encountering an increase in operational problems, then it can be said you are saving money. It was following this line of reasoning that prompted us to look into the possibility of producing light oil at lower cost. Samples of various types of oils were requested and received as to possible substitutes for our then very satisfactory but rather expensive absorbent oil. One, a number three fuel oil, or gas oil, was selected from the number received and proved to have the properties we felt necessary for our particular recovery system. Several tank trucks of this oil were bled into our system with our regular oil, while at the same time a portion was removed from the system so that the change from one oil to another was very gradual. A careful watch was kept on operating conditions and recovery data during and since the change over. This was started shortly after the steel strike in 1949 and was completed about the first of the year. Since that time we have been using gas oil as our absorbing oil in our light oil recovery system with the following results:

1. Our recovery has not suffered.
2. Our system has remained as clean or cleaner with this oil.
3. Our products produced have retained their same high quality.
4. We are saving 4½ cents a gallon on the oil delivered at our plant.

We recognize that oil suitable for use at one plant may not be universally acceptable but, from our experimentation with using a cheaper oil, we strongly recommend it to others who are interested in saving money in their operations.

TEMPER ROLLING WITH MODERN CONTROL

by J. F. SELLERS, Engineer-in-Charge D-C Design, R. M. Peeples, Engineer and A. C. HALTER, Engineer, Control Section, Engineering Department, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

▲ SINCE temper rolling was first initiated as an important process in the manufacture of steel strip, many changes have taken place. These changes have been principally the result of greater concentration on the temper rolling process.

New types of mills and revisions of existing mill designs have been rapidly introduced, and with these changes higher speeds and closer control have become the rule.

A study of the electrical drive equipment on several dozen temper mill installations dating from the earliest applications provides a reference to temper mill practice. A picture is provided of the methods which have been followed in applying electric drives to this type of mill, and a view obtained of the pattern which developments have taken.

Rolling data taken from a cross section of this installed capacity provides an effective indication of practice on these mills, with relative evaluation being made of the factors in the mill setup, such as tension, friction, etc.

Modern temper mill layouts of power and control can then be planned with the help of an increased volume of data from various mill setups, including different electrical solutions in practical use. It will invariably be the case that planning a new installation for the temper mill job will involve making several choices on items ranging from the mill setup to the detailed control.

Assembly of the various data on present mills and application of our increased knowledge of the art can be made to show comparisons which will be helpful in plotting the sensible economic course in choosing drive and control.

ACCELERATION CHARACTERISTICS OF TANDEM COLD REDUCTION MILLS

by W. R. HARRIS, Manager, Metal Working Section, Industry Engineering Department and R. W. MOORE, Steel Mill Engineer, Industry Engineering Department, Westinghouse Electric Corp., East Pittsburgh, Pa.

▲ DEVELOPMENT of tandem cold reduction mills has progressed at a phenomenal rate since the first mill was designed and installed in 1928. Modern high speed tandem mills have maximum speeds of 4700 to 6200 fpm and the maximum horsepower applied to the drives of any one five-stand tandem cold reduction mill is 17,250.

The drive acceleration characteristics have become

of paramount importance as the speed of the mills has increased. One of the first successful methods of improving acceleration characteristics was IR drop compensation by means of booster generators. The development of the individual generator system of stand control has improved the flexibility of stand adjustment since both IR drop compensation and automatic inertia compensation can be obtained as required.

The per cent accelerating torque has been generally used as a basis of drive performance, but alone it means little except as to commutating limits. The true measure of the accelerating ability of motors is the per cent IR drop lag which is the per cent full load accelerating torque multiplied by the full load per cent IR drop. This factor represents exactly how the motor speed lags on applied voltage since it takes into account mechanical inertia, accelerating current and motor design factors. The IR drop compensation used will affect the per cent IR drop lag, but the per cent IR drop lag can be modified to take this factor into account. The amount of IR drop compensation used is determined by operating practice.

The per cent IR drop lag cannot be matched closely between stands for all rolling schedules although with careful study good matching can be obtained. With fast response, precise stand regulating systems, the individual generator voltages of individual generator control systems can be controlled to compensate for differences in per cent IR drop lag.

The acceleration performance of the reel drive is as important as that for the stand drives. Inertia compensation can be used with a fast response well damped regulator to obtain essentially the same tension during acceleration and deceleration as obtained with steady rolling.

Accelerating characteristics of tandem cold reduction mill drives as well as steady operating adjustments are important in obtaining good gage control. Off-gage material cannot be eliminated, but it can be minimized to a large extent by means of proper drive control adjustment and good mill operating practice.

GRAPHITE AS A LUBRICANT

by E. S. GLAUCH, Mechanical Engineer, Joseph Dixon Crucible Co., Jersey City, N. J.

▲ THIS paper deals primarily with graphite as a lubricant and its use in lubricants. Graphite is now being used throughout industry for a multitude of purposes because of its many and unique properties. It is unctuous, a feature which often causes the reference "greasy" to be applied to graphite, although it contains no oil or grease. Graphite marks readily, burns slowly, and is almost chemically inert. It also is a good conductor of heat and electricity, has excellent weathering properties, and mixes readily and homogeneously when combined with oils or greases.

Records indicate that graphite has been used as a lubricant for more than one hundred years and the paper cites records of tests dating as far back as 1829.

The paper refers briefly to information published in "Iron and Steel Engineer" some years ago, indicating power savings that were effected under actual steel mill conditions where graphite lubricants were used to replace plain lubricants, previously considered satisfactory.

Information is also presented pointing up differences between various grades of graphite and their effect on wear when used in lubrication. In addition, many other uses for graphite as a lubricant are described. There have been many advances made in lubrication of equipment in recent years which, in some cases, have eliminated the need for a solid lubricant such as graphite. Because of special conditions such as high temperature, extreme pressure or inability properly to apply fluid or semi-fluid lubricants, graphite still serves a definite, irreplaceable need in industry. New uses are being developed from time to time.

EXTREME PRESSURE LUBRICANTS

by JAMES H. LEWIS, Lubrication Engineer, Carnegie-Illinois Steel Corp., Clairton, Pa.

▲ THE paper describes extreme pressure lubricants as applied to industrial equipment, and the importance of the selection of the type of extreme pressure lubricants procured, especially if intended for general use. The advantage of using extreme pressure oils on equipment where overloading may be occasional, even though manufacturer may recommend straight mineral oil is given.

Various methods and analyses to determine the need for an extreme pressure lubricant and the steps necessary to maintain film strength on units which positively require an extreme pressure lubricant are covered. Data is given on stability of extreme pressure gear oils in regards to film strength and laboratory analyses most generally accepted for determining loss of film strength, and how to maintain film strength in units which are under constant extreme pressure particularly during break in periods.

Given also are advantages of using extreme pressure gear shields on open gears including savings in repair and maintenance in addition to quantities used to maintain sufficient film of lubricant between gear teeth. Application of such lubricants are compared to conventional types of gear greases including safety factor which is desirable in industry. The savings realized by use of all types of extreme pressure lubricants due to standardization, less inventory overhead and savings in processing orders for purchasing are covered.

CENTERLESS TURNING OF BARS, BILLETS AND TUBES

by WALTER SIEGERIST, President, The Medart Co., St. Louis, Mo.

▲ CENTERLESS turning has developed markedly in the past few years. In the process, unlike centerless grinding, the work piece does not rotate as it moves by the cutting tool. When the thickness removed from the surface is heavy, the process is normally called peeling and one common application in steel plant work is the peeling of billets. In centerless turning, production in

general is limited by the speed the cutting tools will stand rather than by equipment. For example, speeds may be obtained at which the tool tip speed will vary from 50 to 100 fpm. Feed rates may vary from 8 in. per minute on a difficult alloy to 72 in. per minute with a free turning steel. The foregoing statements apply to high speed tool steels which are turning bars from 1¼ to 10 in. diameters.

In the past few years, a new centerless turner has been developed for the use of carbide cutting tools. This is used normally on smaller bar diameters ranging from ⅜ to 2 in. The bars are supported within ½ to ¾ in. of the cutting tool and this furnishes the rigidity necessary for carbide turning. With this equipment, tool tip speeds may be varied from 150 to 600 fpm and the feed rate for most materials will run from 4 to 10 fpm.

Modern high speed turning will hold a tolerance of 0.005 in. and with care tolerances down to 0.002 in. may be obtained.

LABORATORY SCREENING OF MULTI-PURPOSE TYPE GREASES FOR PLANT PERFORMANCE TESTING

by E. M. KIPP, Chief, and C. A. ZEILER, Research Engineer, Lubricants Division, Aluminum Research Laboratories, Aluminum Co. of America, New Kensington, Pa.

▲MULTI-PURPOSE greases are commercially available which offer certain advantages, particularly to the large consumer. Their use permits economy in inventory and purchasing and for many applications may increase performance with no over-all increase in cost. The selection of multi-purpose greases presents a number of difficulties. In attempting to meet these difficulties, while avoiding the problems which would be associated with plant performance testing when many greases are to be examined, a series of ten laboratory test procedures are utilized in selecting greases for performance testing. The laboratory test procedures are functional in nature and do not emphasize composition of a grease. The general nature of the laboratory tests employed are individually summarized and the method of using the results from each test procedure reviewed. The means employed in utilizing the combined results of the laboratory test procedures are also reviewed.

It is further indicated that on the basis of plant performance testing under controlled conditions and in a variety of applications, development and application of multi-purpose greases as selected and tested in the manner indicated is a practicable and worthwhile procedure.

ANALYZING OPEN HEARTH DATA — STATISTICS VS. OPINION

by WADE R. WEAVER, Director, Steel Conservation and Quality Control, Republic Steel Corp., Cleveland, Ohio.

▲ IN nature, the result of protracted inbreeding is inevitable lack of progression, if not actual regression. Breeders of strong stock are always searching for new blood to improve the strain. The analysis of open hearth data, the outgrowth of many years of exchanging ideas, copying systems, transposition of supervision, etc., has reached a somewhat similar situation, and has become quite stereotyped. The result is a body of traditional concepts which, in extreme cases, might be termed the folklore of operation.

A series of tools not new, but until recently rather narrowly used, provides ways of extending our present knowledge of operations, sharpens up our decisions, points out where to devote our major efforts, so that the reward will be the greatest. This paper stresses the use of these tools for getting the most out of a set of data, for providing facts as contrasted to opinions. It points out the necessity for a little revision in our thinking by discussing some concrete situations.

Typical, everyday problems, such as tons per hour and scrap charging time are analyzed by a method of sufficient simplicity to be executed by any superintendent's clerk, with an end to assisting in improvement of these vital factors. The application of other techniques, requiring some specialized knowledge, is discussed. The ability to separate random, chance-cause variation from cause and effect variation in the complex open hearth process is of extreme value and a typical case is discussed.

Stress is placed upon the importance of presenting the interpretations of a statistical analysis to the operators in a useable, understandable manner.

TELEVISION IN INDUSTRY

by J. A. GOOD, Manager, Electronics Department, Diamond Power Specialty Corp., Lancaster, Ohio.

▲ THE topic "Television in Industry" covers the need for the development of television in industry. This was established by a rather thorough survey of industry to determine various uses of industrial television, where the installation of this equipment could pay for itself from the standpoint of:

1. Accident prevention.
2. The direct reduction of operating expense.
3. The reduction of operating expense by the reduction of capital required to make information available at a remote point.

Application of television to industry was given careful study so this new tool or instrument for industry would not be misapplied.

Nearly all walks of life—manufacturing, surgical, shows, banking, coal, steel, public utilities, nuclear physics, and power plants were fertile fields for sound applications.

The design of such equipment had to be such that minimum maintenance was essential. All factors embodied in a design were given careful consideration in the production of this type of wire-line television. It was necessary to "give and take" in the design of equipment which would meet the needs, and fulfill the requirements of simplicity of operation and maintenance.

Many of the possible applications for the equipment will be illustrated by the use of an operating unit.

ELECTRICAL FAULT INDICATOR REDUCES DOWN TIME

. . . . the fault indicator will prevent costly shutdowns because it can help determine the cause of transitory disturbances . . . .

By R. W. COCHRAN*
R. W. Cochran & Sons
Pittsburgh, Pa.

▲ "PREVENTIVE Maintenance" has become an important consideration in the steel industry. It is desirable and productive of great savings. Preventive maintenance is, however, easier to apply to the mechanical features of a mill than it is to the electrical. This is especially true in the complicated and interlocking circuits of the electric equipment operating the various functions of an integrated producing unit.

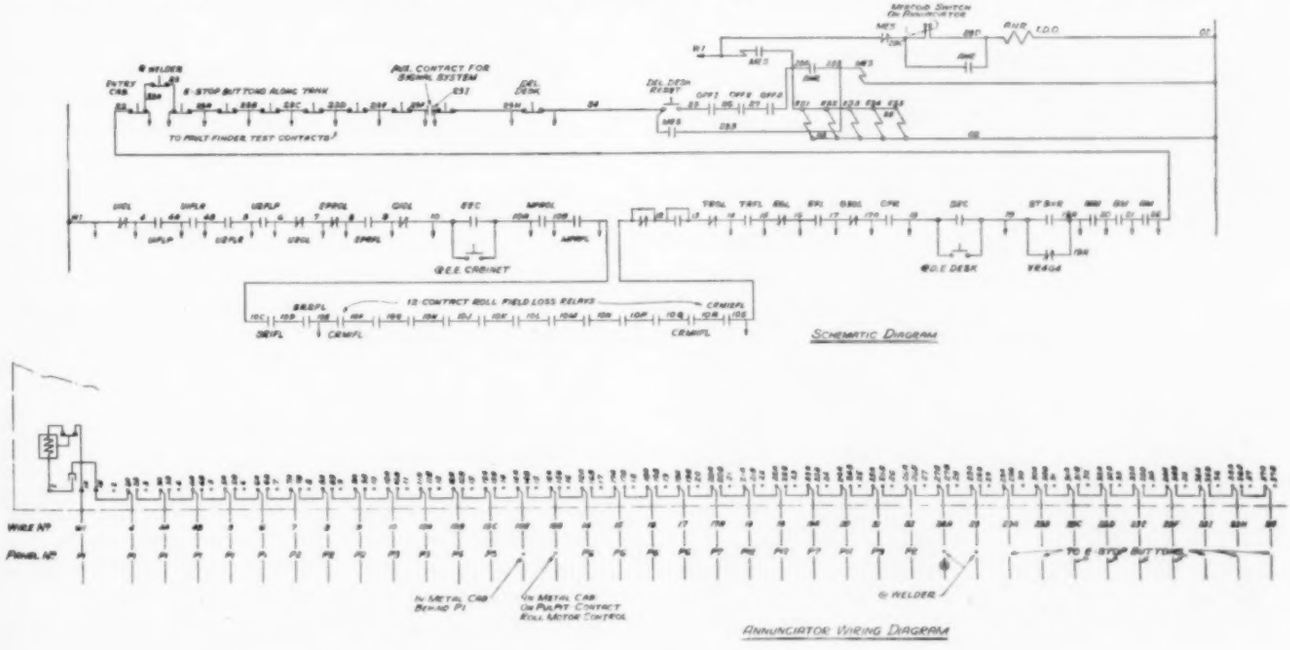
High-speed producing units are installed at tremendous cost. Because of the cost involved, it is essential that these units run smoothly with a minimum of lost time so as to achieve the full production for which the units were designed. These producing units because of their capital cost and their high operating speed include protection for the personnel as well as the equipment. Therefore, a number of safety devices are provided to protect against electrical and mechanical failures and to provide necessary emergency stopping points along the production line.

An electrolytic tinning line is an example of such a producing unit. One such line has 51 different protective control circuit contact points to open up the under-voltage relay circuit in case of a fault. These consist of overloads, field circuit protection, etc., of the generators and motors, bearing temperature, over-and-under temperature relays, loss of cooling and heating or drying air, water and oil-pressure relays, crash and strip break trips and many other protective devices. In addition to the above protective devices, there are emergency stop buttons, mounted along the machine and on the entry control cabinet and delivery control desk. Such a circuit is shown on Figure 1 showing the many points where anyone of the various protection devices, when operated to function protectingly, will stop the entire line. This scheme requires the assistance of an authorized motor inspector to reset, also logging the trip number, date and time, etc.

Failures at many of these points are not easily detected and yet may be caused by poor contact, vibration, dirt or other causes, besides the normal operation of the protective device. Consequently to deter-

* Due to Mr. Cochran's death, paper was read by Joseph F. Reis, Jones & Laughlin Steel Corp., Aliquippa, Pa.

Figure 1 — This circuit for an electrolytic tinning line demonstrates that fault failures would normally be difficult to determine, because there are so many preventive devices which may have caused the fault.



mine the exact point that caused the shutdown frequently requires much time to locate and results in a considerable loss of production. During shutdown it may become necessary for several men to watch the operation of a number of relays in order to observe which one is causing the stopping of the line.

Other shutdowns may occur for which the cause cannot readily be assigned, such as by the unintentional or malicious operation of any one of the emergency stop buttons. However, such unnecessary shutdowns may be denied by the operators or the blame is thrown on the failure of the protective system.

The foregoing dictates the necessity of some means of quickly identifying the fault point, permitting quick correction; thus quickly restoring production.

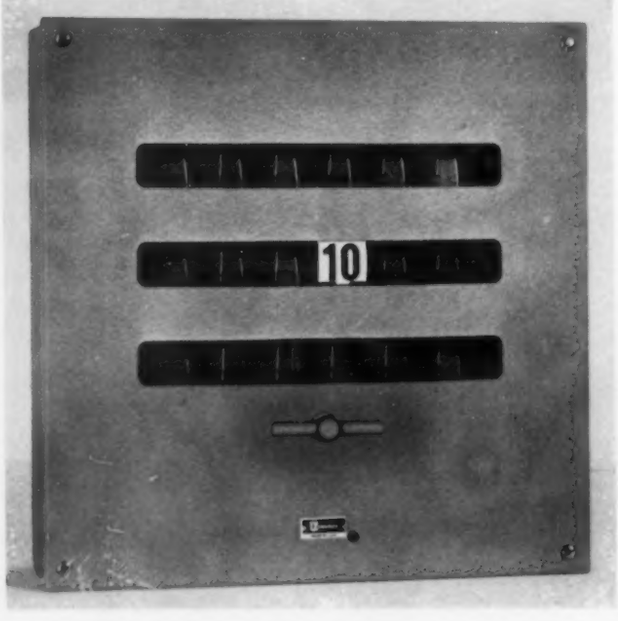
Various means have been attempted. The most prevalent device in use today is a manually operated rotating dial switch which when operated will indicate by lights when the various circuits are completed. However, this light and dial switch arrangement only indicates a permanent fault that may occur on electrical contact. If the fault condition is of a transitory nature, it may have been corrected by vibration, voltage fluctuations, etc., before the machine is shut down, and when the rotating dial switch is operated all circuits give good indications. Therefore, it is impossible, by this method to determine what caused the fault.

The fault indicator was developed to reliably indicate the operation of all protective features as covered by it, whether due to normal operation of the device or a fault in their contacts.

This indicator consists of a number of target relays mounted in a steel cabinet with a glass front with the targets numbered or named for their particular points in the circuit. Such an indicator panel is shown on Figure 2.

The fundamental circuit of the d-c indicator is shown on Figure 3. This consists of a shunt circuit around each of the contact points of the protective devices. This circuit consists of a condenser, the indicator operating coil and a normally closed interlock on the indicator.

Figure 2 — The indicator panel is telling which device has caused the fault.



The protective device contact shunts this circuit under normal conditions; thus the indicator circuit is subject to no current flow. The condenser prevents the possibility of the target circuit conducting sufficient current to hold in the under voltage relay. The target control circuit prevents any possibility of current flow after it trips.

On tripping of the protective contacts, the target circuit is then placed in series with the under voltage relay coil. Since the condenser interrupts the circuit to the under voltage coil, its stored energy is dissipated as an inductive kick. This induced voltage causes a current to flow through the target coil to charge the condenser, and this trips the target, dropping the indicator and opening this circuit through the interlock. Thus the tripping of the target is independent of any outside source of voltage, but is dependent only on the stored energy of the under voltage relay coil.

If the interruption of the protective circuit is momentarily due to some cause, the fault indicator will not prevent resumption of operation, but the target dropped will remain down and on the next inspection it is apparent that some fault existed in the protective device or circuit or that one of the emergency buttons was operated.

An incidental advantage occurs because the condenser in absorbing the inductive kick of the undervoltage relay coil eliminates the burning of the contacts of the protective device or relay.

This positive indication eliminated frequent shutdowns that were formerly blamed on some unknown cause, but in reality was due to one of the emergency stop switches being operated. During the period since the fault indicator has been installed, the number of outages were materially reduced and the outage time of those that occur due to the normal operation of a safety device were also reduced.

Another installation on which the shutdown time has been reduced is a blast furnace skip hoist. This skip hoist has 24 contacts in the undervoltage relay circuit; consisting of overloads, field loss, overspeed, final stop limit switches, slack cable limit switches, bearing temperature, and others.

Previous to the installation of the fault indicator, only the most experienced motor inspectors could determine and locate trouble on a skip hoist control. Since the installation of the indicator it has become common practice for a helper to investigate reported stoppages and he can immediately tell upon viewing the indicator if the failure was due to some point in the undervoltage relay circuit.

An outstanding example may be cited as the value of the fault indicator on a skip control. On a particular furnace during a 24-hour period, there were frequent stops and all the skilled motor inspectors and foremen were unable to observe any fault in the circuits. The skip would be out of service and no apparent cause could be assigned, with all circuits ringing out perfectly. Without any corrective measures the control

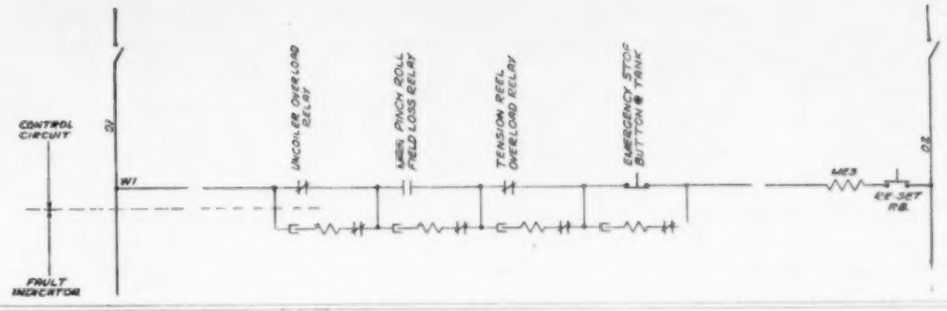


Figure 3 — The schematic diagram shows a typical connection for a d-c fault indicator.

would function on operation of the master switch with the control functioning perfectly and then later another shutdown.

A 4-drop fault indicator was temporarily installed with the protective contacts divided into groups under each drop. The next failure of the control indicated a particular group and then the four drops of the indicator were connected across the individual contacts in this group. The next failure indicated that the trouble had been with the field failure relay and on examination it was observed that the copper contact tip was oxidized and sintered, and under conditions of voltage would lose contact and shutdown the skip hoist. This source of trouble would have been indicated the first time that the skip had shutdown if the fault indicator had been installed.

Another outstanding incident on the same furnace drive after the permanent installation of fault indicator was on a contact in the lilly controller. Due to vibration this contact had developed a sinter and under certain voltage conditions opened the circuit to the undervoltage relay. The first failure was indicated on the drop, and the source of trouble immediately determined and this particular contact shunted out until it could be repaired. Because of the location of the contact in the governor, its failure would not have been readily visible.

Another successful application of the fault indicator has been on an air conditioning unit for a blast furnace. This fault indicator consists of eleven drops, and these are connected across the following protective contacts —stop, Hydraulic Oil Pressure, Refrigerant Temperature, Chilled Water Temperature, Differential Flow Pressure, Condenser Pressure, Oil Pressure, O.L. Control Relay and Control Circuit Fuses. Before installation of the fault indicator, the cause of the failures were not apparent because under the arrangement of the units, on stopping, the failure that caused stoppage would correct itself. There had been several costly shutdowns due to the inability of inspectors to immediately determine the fault. After installation a fault indicator, a failure in any of the protective features was indicated. This ability to immediately determine the source of trouble is invaluable.

There are many complicated electrical drives in all industries where a large number of protective safety devices are required. The fault indicator is a valuable asset in preventive maintenance. The indicator with slight modification in the circuit can also be used on a-c systems.

The indicator cabinet can be arranged for magnetic reset. However, the most desirable is manual reset by a small lever projecting from the cabinet. Practice has indicated that on some installations that it may be advisable either to lock the reset handle or to locate the indicator so that it is not accessible to other than qualified motor inspectors. In a very short time, operators became acquainted with the fact that the fault indicator definitely places a finger on them if they are the cause of an unnecessary shutdown. No one now can any longer blame the delay on some mysterious quantity "X." If the indicator is not accessible to them, then there is no possibility of their resetting the indicator or removing the evidence. In addition to the units referred to the fault indicator would be a valuable addition to the control equipment of most of the integrated processing units and to name a few which are familiar: hot strip, paper, pipe and tandem cold reduction mills; aluminum sheet and foil mills; continuous annealing, electro cleaning, electro tinning, galvanizing, shearing and slitting lines, elevators, printing presses, and it may also be used on experimental and test work and many other applications to numerous to list in this paper. In many cases the investment cost of the fault indicator may be written off during the starting up period.

Experience to date shows that the indicator has proven that it has a definite value, will prevent costly shutdowns and is of real advantage in a preventive maintenance program in which electrical equipment is involved.

DISCUSSION

PRESENTED BY

C. O. FRANKLIN, General Supervisor, Electrical, Carnegie-Illinois Steel Corp., Munhall, Pa.

JAMES D. O'ROARK, Electrical Superintendent, Weirton Steel Co., Weirton, W. Va.

J. F. REIS, Electrical Dept., Jones & Laughlin Steel Corp., Aliquippa, Pa.

VINCENT E. OSWALD, Chief Electrician, American Steel & Wire Co., Donora, Pa.

MARION H. MORGAN, Assistant to Chief Engineer, Carnegie-Illinois Steel Corp., Youngstown, Ohio

C. O. Franklin: We have one of those devices in our plant and it has proved very beneficial in locating troubles.

James D. O'Roark: Might you tell us how much wiring is involved in installing one? Is there a connection across each possible opening, a small wire, or just how much trouble is it to add to an old installation?

J. F. Reis: Two wires are required for each protective device or contact covered, to connect it in parallel with its respective drop of the indicator. The wire size required is relatively small, ordinarily standard No. 12 switchboard wire is used. Existing control installations are not disturbed other than that required to connect the indicator lead wires to the respective terminals. The cost of the installation depends on the number of drops required.

Vincent E. Oswald: Can this equipment be used as a ground indicator at the same time it is being used as a trouble indicator?

J. F. Reis: I do not know of such application. It could be so used if the ground relay contact would function in the undervoltage circuit.

Marion H. Morgan: I would like to ask if the application of this device requires proportioning the condensers to the capacity, and therefore the inductive kick of the coil of a low voltage device, or whether you could use it on any low voltage coil without having to change the condensers, and still have it function the way you have described?

J. F. Reis: The condenser units are standard items and not tailored for each application.

Marion H. Morgan: And so you do not have to proportion them?

J. F. Reis: These units are of standard construction available in the number of drops required for use on 10, 220 or 440 volts a-c and 250 volts d-c as specified, and no other electrical characteristics of the circuits are required.

Member: You are talking about preventive maintenance. Do you not think preventive maintenance would eliminate the use of the device?

J. F. Reis: This device will indicate a fault, and it will assist in the preventive maintenance program in so far as it indicates the points where faults occur. Notation should be made of the frequency of each fault point registered and the causes corrected. I have observed a target indication as a result of a slight movement of a contact which did not appear to be opened. It is very quick and interesting to observe how quickly the indicator functions.

Member: In conjunction with this gentleman's question in regard to tailormade apparatus, it would be my opinion that you would at least have to specify the voltage that it was to operate on. It seems to me that an annunciator system is designed to operate at a certain voltage and it might be possible that it would not operate on a lower or higher voltage, and that the capacitor would not operate. I assume it is on 250 volts, and it is possible it would not function on one at 125 volts, or possibly on a system functioning at 500 volts, which is not out of the question.

Another question I would like to ask, are these as manufactured well enough insulated to withstand the voltage that we usually use on control systems?

J. F. Reis: My experience with these fault indicators has been on 220 and 440 volts a-c and 230 volt d-c. I believe that they would operate satisfactorily on 125 volts. Control circuits of 500 volts or above are not commonly used in industry. Should the inquiry call for such an application, the fault indicator supplied would work satisfactorily. The insulation provided would meet standard test specifications covering the circuit voltage specified.

DIESEL LOCOMOTIVE MAINTENANCE PROCEDURE

By R. L. BAKER
General Electrical Foreman
Union Railroad
East Pittsburgh, Pa.

. . . . steel plant railroad men can obtain valuable data from the railroad operators . . . .

▲ FIRST the writer will give a brief outline of the Union Railroad as to the miles of track, operating conditions, number of locomotives and location of inspection facilities. Total track mileage including main line and mill track is 284 miles. It is not uncommon to encounter grades of 1.25 to 2.50 per cent with some branch tracks reaching a grade of 3.00 per cent. Curves of 20 to 40 degrees are not unusual in mill trackage. The greatest continuous grade is seven miles in length with a maximum grade of 1.25 per cent.

Locomotives are operated at maximum amperage and minimum speed limits over ruling grades. These limits are established by the locomotive manufacturers.

Union Railroad diesel motive power at present consists of 10-550-hp, 5-660-hp, 46-1000-hp and 14-1500-hp locomotives or a total of 75 diesel locomotives. By February of 1950 this total of diesel locomotives should be 118. These locomotives are supplied by four different locomotive manufacturers. Inspection and maintenance procedure must be flexible to allow for variation

of design of engine and control equipment.

All monthly inspection, maintenance and all overhaul work on diesel locomotives is performed at Hall roundhouse.

Servicing and inspection of locomotives during the 30 day operating period is possible at any of eight "one point service stations" located at strategic points on the road.

Two important operations that have accomplished considerable savings in manpower and damaged equipment are:

First: Use of distillate of heat plant boiler and treatment of same for use in diesel locomotive cooling system. At the main inspection station, a large volume of this water is treated in a storage tank. Other service stations are supplied with this water by means of a tank placed on a flat car. One man thus controls the condition of the cooling water used in all diesel locomotives. A chromate treatment is used with this water of low hardness to prevent corrosion. The pH value is maintained at 8.5 to 9.5. The concentration of chromate treatment used in the cooling water in Union Railroad locomotives is 2000 ppm. This treatment and close control of the cooling water has proven very satisfactory as evidenced by the condition of cooling systems inspected at overhaul period.

Second: By installing filter cleaning facilities at the monthly inspection point, it is possible to clean all air filters and lube oil containers at one point. This again gives better control of cleaning as the operation can be supervised by the shop foreman in this area. By installing dust proof containers on each locomotive, a spare filter can be inserted at monthly inspection to facilitate any 15-day changeout. The dirty filters are then placed in this container to be removed and cleaned when the locomotive returns for the next monthly inspection.

Formerly, the filters were trucked to the service points. Due to careless handling and bumping received enroute, filters were damaged, quite often completely ruined. If the delivery was not on schedule, the service points would not have the filters to make a changeout. Both of these evils have been completely eliminated by our present procedure.

During this period, the service station is responsible for inspection and minor maintenance to all locomotives working in this area. At the end of each turn, the engineer fills out a form that gives the condition of the locomotive he has been operating. These forms are checked and any fault is corrected while the locomotive is in for service. The number of times a locomotive returns to the service station is governed by the amount of fuel consumed and any equipment failure that can be repaired at this point. These periods range from 2 to 7 days, servicing of each locomotive consumes 20 to 30 minutes.

When a locomotive turns in at a service station, it is fueled, sanded, watered, lube oil checked and replenished, engine is observed for possible fuel and lube oil leaks which are corrected if found. Belts are checked, filters changed per schedule, heads checked for leaking, lights checked, battery cleaned and water added as needed with record noted as to how much water was added and brake shoes are renewed as needed. Any inspection required by ICC law is made at this time. Records are kept of all repairs made, filters changed, specific gravity of batteries, etc.

These records are evaluated by the diesel supervisor in charge of the division in which the locomotive is working, and he in turn notifies the main inspection point of any condition that requires immediate attention. Often serious damage to equipment and delays to crews can be avoided by prompt action and coordination between these service points and the main inspection point. For example, a voltage regulator is reported inoperative which would require considerable time to repair. Hall roundhouse is notified and an electrician is sent to the locomotive with a new or reconditioned voltage regulator, a changeout is made in a few minutes, the engine is placed back in service and the damaged regulator is returned to Hall where the necessary repairs are made.

MONTHLY INSPECTION PROCEDURE

Monthly inspection and maintenance consists of a thorough check and reconditioning of all parts of the locomotive both electrical and mechanical as required by ICC law, manufacturers specifications and those found to be necessary by past experience.

The manufacturers recommendations are used in a pattern when the locomotive is in warranty period. After the first year, enough data and experience has been established to indicate any weak points in the recommended monthly inspection procedure and changes are made to correct them. Manufacturers recommendations are general and for all types of switching operations, but every road operation is different. This places demands and stresses on particular parts and equipment of locomotives that the general recommended inspection procedure cannot anticipate. Quite often, excessive maintenance is recommended, but this also can be reduced safely by referring to records of past operations.

At each monthly inspection, a sample of the lube oil is taken and given a viscosity check, a test to determine the acidity of the oil and a blotter record is kept. A card kept in the cab of each locomotive is used to record lube oil filter change outs and the next date due for same. If the blotter shows the oil to be dirty, the filter changeouts period is lessened and a check is made the next time the locomotive is in for monthly inspection to see if this has cleaned the oil. The cab card is then marked accordingly. Oil changeouts vary from 1 month to 18 months, depending on the condition of the diesel engine. All filters are changed at monthly inspection.

All auxiliaries and accessories are inspected and repairs or adjustments are made. For example, belts are checked for tightness and wear, sanding equipment is checked, fuel oil lines checked for leaks, window wipers, fuel pumps, etc., are checked. All inspection required by ICC laws are made. A record of the condition of all wheels is kept enabling the shop to anticipate a truck change one month in advance. Records are kept of each traction motor serial number, date entering service and bearing lubrication date. This is necessary for the following reasons:

First: Due to truck changeout because of worn wheels, the traction motors are seldom replaced on the same locomotive. A spare truck is used to facilitate

these changeouts. By keeping this record, an average life expectancy of traction motors working under the load your particular road demands can be established for each type of locomotive. Our oldest locomotive is approximately nine years old but the majority are five years or less. In view of this, we have not had sufficient motor failures to establish a definite traction motor life.

Second: To avoid lubrication failures, each individual motor must be treated as a separate unit. Again this changing of trucks relocates these motors. For example, No. 1 and No. 2 traction motors may be scheduled for lubrication at one monthly inspection period but No. 3 and No. 4 are not due until 3 or 4 months later. If your road has different makes of locomotives, you know that the lubrication demands vary. This gives a third good reason for keeping lubrication records. Diesel engines are wiped clean at each monthly inspection and all sump drains are cleaned.

Electrical inspection—This inspection consists of a complete visual inspection of any and all electrical cable, insulation, relays, contactors, motors and generators. Any damage or irregularity is repaired. All ICC inspections and tests are made. Voltage regulators are closely checked for contact wear, arcing voltage setting and freedom of movement. The writer recommends that a "Sequence Test" be made of all contactors, relays and controllers at each inspection. This is performed with a dead engine. Particular attention must be paid to the actual progressive sequence, if not, quite often oversight can be costly. The writer experienced a case where a complete reverser had to be replaced because a $1.50 capacitor failure was not noticed at inspection. With the exception of fuel transfer pumps and cab heater fan motors, all motors and generator brushes should be inspected monthly. The writer has found by keeping records, it is practical to change out fuel transfer pump motors and heater fan motors every six months. By using spare motors, the inspection is not delayed and the old motor can be reconditioned and returned to stock. Motors, generators, and control cabinets are blown free of dust accumulation by dry compressed air of not too great a pressure.

Batteries are washed with water of low pressure and then a solution of one pound of bicarbonate of soda to one gallon of water is poured over the battery and allowed to stand for ½ to 3 hours. This solution is then washed away and the battery is blown dry with air. Distilled water is added to cells if needed. Specific gravity readings are taken and recorded along with the amount of distilled water added. It is advisable to record the date that batteries enter service as this will help in determining the life that can be expected of any given make of battery.

Quarterly, semi-annual and annual inspection and maintenance procedures vary from monthly procedure only in that additional checks and replacements as required by ICC law. For illustration, injectors are replaced every six months, fuel pump and heater fan motors are replaced, air compressor lube oil is changed. Annually, a high potention test is made of all electrical equipment as per ICC law.

OVERHAUL AND LOAD TEST

Mechanical—Locomotives are overhauled every 3½ to 4 years or 25,000 to 30,000 service hours. At this time the engine is disassembled, worn parts are repaired as necessary. Close inspection is made of the complete engine for indication of corrosion, sludge deposits and any irregularity that may shorten the life of the engine. Steps can usually be taken to establish the cause and a remedy can be made.

Electrical—All electrical apparatus is reconditioned, leads and cables are painted to loosen dirt accumulation and to aid future cleaning. All contactors, relays and resistors panels are restenciled as this aids the trouble shooter.

All commutators are stoned, or turned and undercut, according to their condition.

Again, the URR locomotives age is not great enough to establish when the main generator should be overhauled.

Upon completion of overhaul, the locomotive is assigned to light operations for two weeks. It is then returned to the overhaul shop for load testing. The load test is accomplished by substituting a water box resistance load in place of the normal traction motor load. This water box resistance consists of a steel box approximately 6 ft square and 5 ft high. In this box are placed steel plates approximately ¼ in. thick, 4 ft square spaced 2 in. apart, alternate plates being connected together. Each polarity has ten plates making a total of twenty. This size water box will accommodate 250 to 2000-hp locomotives. Water is allowed to enter a 2-in. diameter pipe located in the bottom of the box. An adjustable drain of 5 in. diameter pipe is used to control the level of the water about the plates. The flowing water allows one to maintain a constant load on the generator as temperature rise is eliminated. This box can be built by your own shop for less than $500.

The engine is run at partial load for one hour or better before a test run is made. This allows both mechanical and electrical equipment to reach a normal working temperature. Compression pressures are checked at this time. Full load combustion pressures are taken during test run. Electrical loading of engine is adjusted to match the manufacturers generator characteristic curve.

One of the most important things to remember when establishing a diesel maintenance program is the ability of the maintenance personnel. Unless you are fortunate and have men capable of doing this work, the writer recommends you train men prior to the arrival of your diesel locomotives. Modern shops and maintenance equipment are of little value if manned by poorly trained personnel. The writer suggests contacting Penn State College authorities for information in this field of training.

The writer has attempted to give a general picture of maintenance inspection procedure followed by the URR. There are of course many detailed operations too numerous to mention which must be performed. These clearance checks, timing procedures, control sequence, etc., vary with each make and hp rating of the locomotive. Information of this category can be found in instruction books and bulletins furnished by the manufacturers of the locomotives.

DISCUSSION

PRESENTED BY

S. C. READ, Manager, Construction & Maintenance, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

R. L. BAKER, General Electrical Foreman, Union Railroad, East Pittsburgh, Pa.

W. A. ANDERSON, Assistant Division Superintendent, Maintenance, Carnegie-Illinois Steel Corp., Youngstown, Ohio

S. C. Read: I would like to hear from Mr. Baker whether he has any data on life of the cylinder linings?

R. L. Baker: That question is a little out of my line. As to cylinder renewals, so far most of our operations have been in switching, we are starting to use a switcher as a main line locomotive. We have honed the liners and replaced them without increasing the rings. But so far as replacements go, we have replaced them due to erosion caused by poor design in the water ducts.

S. C. Read: How long have you had diesels in service?

R. L. Baker: About nine years. But the ones this other gentleman referred to as a particular make of locomotive, has been five years or less. We have had two types go through overhaul and another type is starting through overhaul, and we do not know what our changes have accomplished until we see the engine at the next overhaul.

W. A. Anderson: That sounds a little bit like a complicated procedure. I think it is probably very good. There is one thing I would like to know though, if I could, and that is, what is the availability, that is, the useful availability that you expect out of your locomotives? By that I mean, on-the-road time that they are available to be used, this repair time and inspection time being something separate?

R. L. Baker: I am afraid I cannot give you definite figures on that. It may help to give you the time consumed in overhaul, as well as in inspection.

W. A. Anderson: That would be good.

R. L. Baker: The usual inspection, monthly inspection, without any contingencies, is completed in eight hours, sometimes a little less. The overhaul will range from, we will say an average of about three weeks with our present facilities. As I mentioned before, the time spent in the service station is about 20 to 30 minutes.

Member: I would like to ask what is the source of water supply for his cooling system, raw water, city water?

R. L. Baker: It is distilled water. As I mentioned, we take the condensate from our heat plant boiler in the main inspection point. It is a city water when it originally starts.

Member: Then the locomotive has to come back to that point to be refilled, in case they would have to?

R. L. Baker: No, sir, this water is transmitted by tank car to any of eight service points throughout the road.

Member: What is your average life of a diesel engine, before complete overhaul?

R. L. Baker: The average life of the engine before complete overhaul ranges from three and a half to four years, or 25,000 to 30,000 service hours. We found that to be satisfactory. Although any of these values will vary with the particular operation in which the locomotive is working. As I said before, our locomotives are worked at a maximum amperage and minimum speed, some of it over rather severe grades. In other words, we make work horses out of them and we are not concerned about speed.

Member: What is your average life of your brushes on your locomotives?

R. L. Baker: I wish I could answer that question. I would say, traction motor brushes would run around eight months, safely. Some of them will run twice that much and some of them a little under that. We are making some experiments with different types of brushes right now, we have about five to six different types, one of which I think is the answer on the 1,000-hp switcher. I would not care to make any comments on it until it is a proven fact. So far I have 14 months service and I anticipate at least 30 to 33 months, with a beautifully colored commutator and very little wear on 1000-hp switcher.

Although I cannot say the same for traction motors, we have had considerable trouble on traction motor brushes cracking and chipping and eyelets coming loose and the like.

Member: How many miles is that?

R. L. Baker: We figure just about 8,000 hours in a year, that would be about 4,000 miles a month. About 30,000 miles would be about it.

Member: We have been making extensive tests as far as lubricating oil is concerned on these locomotives. You mentioned something about taking blotter tests on your oil. Is that the test you use to determine when you change your oil?

R. L. Baker: That is one of the tests, it is an official test. I can go through that briefly. It is a blotter on which you drop a few drops of oil from the dip stick of the crankcase, and you determine by comparison of the former test whether or not your oil is becoming dirty. And you yourself, or the powers that be on your road, determine how dirty you want to get that engine, or you can work that out with the manufacturers.

Member: Do you believe a color test is sufficient to determine when the oil should be changed? In other words, we ran into this, where we have some oil that from visual inspection looks rather bad but we found after we analyzed this oil it was not very bad at all, it was in very good condition. So that brings us up to the next point, where we think dilution very definitely enters into the picture.

R. L. Baker: It certainly does.

Member: That is why I questioned the blotter test as being an accurate means of determining when oil should be changed.

R. L. Baker: I think I mentioned three checks, acidity, viscosity and the blotter test, which makes three checks on the oil. We take three different tests. We certainly would not change it out or allow these other things to exist, because I doubt very much whether water or acid would make any difference on a blotter test.

Maintenance of Diesel Electric Locomotives

for Switching Service

. . . . keeping the diesel locomotive running efficiently requires a careful, exacting, well-planned maintenance program . . . .

By HENRY C. JONES
Assistant Superintendent
Patapsco & Back Rivers Railroad Co.
Sparrows Point, Md.

▲ DURING the middle of the late thirties, the railroads of this country began to give serious consideration to the use of the diesel-electric locomotive as a tool which might reduce fuel and maintenance costs, and, at the same time do a better job of switching cars than the conventional steam locomotive was able to do. These objectives have been realized, and the current widespread use of this type of motive power is a matter of common knowledge.

The desirable characteristics inherent in a diesel-electric locomotive such as, lower fuel cost, reduction in number of units necessary to do a job, lack of smoke, good visibility, and lower maintenance cost, cannot be fully realized unless facilities and personnel suitable for maintaining and servicing this type of power are provided.

Shops, designed and tooled for steam locomotive maintenance, will not be found suitable for diesel locomotive work unless they are cleaned up and certain modifications are carried out. This does not infer that large capital investments in building and other plants are rendered obsolete, but rather that certain precision tools are required, and that other facilities are provided to handle a cleaner and more precise type of machine.

The problem of maintenance is very important, as the smooth functioning of the operating end of a railroad, and its earning power depends, in large measure, upon the availability of locomotives that will do their job, hour after hour, month in and month out, with an absolute minimum of failures.

The facilities for, and some of the techniques used in maintenance on the railroad, for whom I have the good fortune to work, form the subject of this paper.

We operate on the fundamental precept that a locomotive will give four years, or say 32,000 hours, of service before doing a piston, head, liner, and bearing repair or replacement job; and that it will operate a further four years before it becomes desirable to remove the engine from the locomotive bed for a complete overhaul.

During the interims it is, of course, legally and mechanically, necessary and desirable to bring a locomotive to the shop each month for inspection, including filling out the forms as called for by the Bureau of Locomotive Inspection of the I.C.C.

To carry out this work, we use an assigned force on each of two shifts, consisting of the full time services of five mechanics, and on the day shift only, a portion of the time of three other mechanics and laborers, as attention to certain appurtenances might be required on 33 locomotives, varying in age from one to fifteen years.

For a routine monthly inspection, the locomotive is brought to the shop by hostlers and positioned on a concrete apron where steam, water and air lines are provided. With traction motor blowers operating, to prevent water from entering the motor frames, laborers wash down the trucks, traction motors, and underside of the locomotive bed using steam guns, hot water, and an alkali cleaner. The mechanics, during the same period, wash down the diesel engine, air compressors, radiators, and fans with small hand guns utilizing a suitable grease solvent and air.

This cleaning requires about 45 minutes, and is done to provide cleaner working conditions, to prevent the ingress of dirt to interior mechanisms, to reduce the fire hazard, and to enhance the esprit de corps of the operating crews.

The locomotive is next brought into the shop over a four foot pit provided with deck and hood level platforms, and depressed floors on each side of the locomotive. The assigned group then inspects, repairs, and adjusts all mechanical equipment above deck level including; the diesel engine, fans, shafting and belts, oil and water radiators and shutters, air compressor and coupling, traction motor blowers, cab and hood structures, glazing, and many other minor items. One man checks couplers and draft gears, measures wheels for cracks and flat spots. He also goes over the spring and brake rigging and motor nose and axle suspensions. Another mechanic checks and replaces, as required, brake valve equipment, makes tests to gages and air compressor as required by law, and all other devices such as bell ringers, sanders, horns, and air throttles. Pipe work is the responsibility of everyone. Two, of the group of mechanics, clean, and go over all switch gear, generator, motors, and other ancillary electrical devices.

Due to the dusty atmosphere in which our locomotives

Figure 1 — This kinematic viscosimeter makes possible the determination of six values very quickly.

sometimes operate, we normally replace dirty engine air filters with clean ones once each week. If the particular locomotive is operated under extremely dusty conditions, the filters will be changed after three days use. Air compressor filters will normally operate one month between servicing.

Lubricating oil filters are changed as tests on the oil indicates. Our small laboratory is equipped with three pieces of apparatus for the testing of engine lubricating oil, and we have found them most satisfactory for the purpose. The first item is a kinematic viscosimeter (Figure 1) operated at 100 F, and capable of dealing with six A.S.T.M. modified Ostwald Fenske viscosity pipettes, enabling us to determine six values quickly. We retain oil only when the fuel oil dilution is less than 5 per cent. The second tool is a simple hot plate for detecting the presence of water in the oil. The surface temperature of this plate is raised to about 350 F, at which time a few drops from each sample are deposited on the surface, and the presence of water is easily detected by the popping and spitting, even if present in very small quantities. The third and last apparatus check is made for a combination reading of free carbon and oxidation in an electrophotometer (Figure 2). A 2-millilitre sample of used oil is diluted with 98 millilitres of precipitation naphtha to form the sample for testing. A like dilution of new oil in naphtha is the standard of comparison. Thirty cc volumes of each of these solutions are placed in the photometer, and the light transmission is balanced at 100 per cent through the new oil; the used oil sample then replaces the standard, and the increase in light absorption is measured. The reduction in transmission is due partly to the gradual oxidation of the oil, but principally to the minute solid matter in suspension. The approximate neutralization number of our oil is determined by the appearance of rings on a blotter spot test. With unoxidized oil, a center spot, of varying density, will be formed with a large light yellowish brown ring on the outside. If the oil is materially oxidized, there will be two concentric outer rings around the center spot. The one next to the center will be light gray in color, and the outer ring will be dark brown, the shade of which is a rough approximation of the amount of oxidation present. We have checked these determinations many times against conventional methods, and are satisfied that they are adequate for all practical purposes.

Used lubricating oil is reclaimed for further use as make up oil by a four step process. First, the oil is mixed with activated clay, and particles coagulated out; secondly, it is subjected to vacuum distillation and steam stripping; the third step involves neutralization and filtering; and the last, refortification with a detergent additive. The amount of oil available for reclaiming is quite moderate, and the yield forms not more than 30 per cent of the consumption of makeup oil. This is used by our fleet of locomotives at the rate of about 2 gallons per 24 engine hours.

Fuel oil filters on our locomotives are replaced quarterly, unless some abnormal condition requires earlier attention. These filters are located on the suction side of the transfer pumps, pass 75 gal per hr, and must be reasonably clean or they will shut the engine down, as no bypass valve is provided. Our experience with fuel oils of widely varying character has led us to the

Figure 2 — The electrophotometer is used to determine free carbon and oxidation.

Figure 3 — Locomotive maintenance is carried out in this shop.

conclusion that our interests are best served by the use of a high grade fuel oil that is low in sulphur, under 0.5 per cent, with an end point not exceeding 650 F, and a cetane number between 45 and 50. The great reduction in cylinder deposits, wear, and combustion shock afforded by a high grade fuel oil make a heavy contribution to the reduction of maintenance costs.

We use treated rain water in our cooling systems. The effluent from the roof of our shop is led to a 45,000-gal storage tank by means of appropriate gutters and a six-in. pipe, and, has proved, in our climate, to be more than ample for the demands of 33 locomotives both winter and summer. Its merit, of course, lies in the absence of scale forming material.

The shop in which we carry out our locomotive maintenance is a steel framed structure, with a main bay 180 ft long by 60 ft wide. See Figure 3. Twenty foot leantos on each side of the major axis complete the floor area of 18,000 sq ft. Four transverse tracks are located in one end (Figure 4), utilizing 6400 sq ft, or about 35 per cent of the total floor area. The balance is devoted to working space, machine tools, specialty shops, welfare rooms, and office. A 20-ton capacity overhead crane, equipped with two 10-ton trolleys, whose hooks clear the floor at 30 ft, serves the main bay as shown in Figure 5. This crane is capable of dealing with the movements of complete engines and generators, trucks, or any other lift within the requirements of the operation, except complete locomotives. This function is well handled by four, high lift electric jacks, each rated at 35 tons. A synchronizing control

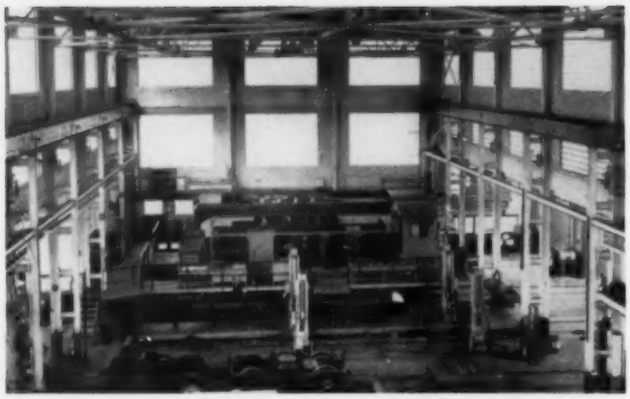


Figure 4 — The shop has four transverse tracks which cover about 35 per cent of the total shop area.

permits two men to make a safe lift of a complete locomotive. Trucks are rolled from under the raised locomotive chassis by their traction motors receiving energy from an d-c welder, to a position within range of the overhead crane.

The maintenance of wheels in our shop has resolved itself into a rather simple operation by virtue of a wheel tread and flange grinding machine (Figure 6) that we have used for several years. Without any truck disassembly, except removal of axle end thrust bearings, each axle, in turn, is positioned by live centers, is turned by its own traction motor, and two men then restore the tread and flange contours by use of two high speed grinding wheels governed by a power cross feed and a vertical hand feed. In eight hours these two men can recondition the wheels in one truck, thereby saving a vast amount of man-hours over the conventional method of dismantling the truck to remove the axle and wheel units and turning same in a lathe. Later models of the same machine, equipped with hydraulic controls and more powerful grinding head motors will undoubtedly perform this job in still less time. Virtually no other work on our trucks is necessary between wheel changes (averaging four years), except that made necessary by reason of derailment or collision. At the time of wheel renewal, however, we renew all pins and bushings, wear plates, etc. that will not render a further four years of service. Truck suspension springs and traction motor nose springs are also cleaned, inspected, and repaired for a minimum anticipated life of four years.

The traction motors also come in for their share of attention during the period of truck overhaul. They are disassembled, thoroughly cleaned and inspected, the armature and inside of field frames are painted with air drying varnish, commutators are turned and undercut, if necessary, and the armature roller bearings are very carefully inspected and renewed if there is any sign of brinelling of the races or spalling of rollers or races. We have never considered it necessary to provide either dipping and baking equipment, or facilities for rewinding, as the record of failure is so clear, that such tools would be an unjustified economic burden. For this type of work, the unit is turned over to a reliable electrical repair shop. The method used in our shop for pinion installation has proved very satisfactory, and the method of controlling the pinion advance has an element of novelty. The pinion is blued to the shaft cold, and a fit of 80 per cent, or better, is obtained before proceeding with its application. To provide a positive stop for the pinion, when placed in position after heating, a small screw or clamp is fastened to the end frame of the motor, and clearance between it and the pinion is set at the recommended advance plus 0.005 in. when the work is cold. The gear is then heated to 350 F on an induction frame and pushed on manually until it contacts the stop. This renders the use of a micrometer depth gage, with the attendant difficulty of handling on a hot pinion unnecessary.

Before passing from the subject to trucks, mention should be made of the three methods employed to extend the flange life of the wheels; first, the back to back gage of the mounted wheel sets are held at 53 1/8 in. which is 1/4 in. less than the conventional 53 3/8 in., secondly, track flange lubricators are located at strategic points on our track system and have a beneficient effect on both locomotive and car wheels, as well as the rails themselves; third, an unconventional method is used for truck center plate lubrication. At quarterly inspections, the locomotive body is raised until the male center castings clear the top of the truck bolsters by several inches. The sides and bottom of the female centers are liberally painted with a paste composed of graphite and oil. Number 00 crater compound is then poured in to a depth of about one inch, and the locomotive body is lowered into position for a further three months service. These three factors coupled with sufficient side bearing clearance have given a great reduction in our wheel wear.

The diesel engine is, as most operators are well aware, the most expensive item to maintain, and is generally the least reliable unit on a diesel-electric locomotive. It should, therefore, be the subject of the most careful thought and attention that the manufacturer and user can exercise in its improvement and care. As mentioned earlier in this paper, it is considered to remove the engine and generator from a locomotive after about eight years of service. It is true that many engines will run for ten to twelve years without this type of overhaul, but experience indicates that somewhat earlier attention is desirable in order that more expensive repairs may be minimized. After the engine and generator are removed from the locomotive body, the engine

Figure 5 — Adequate crane service helps speed the shops operation.

is completely disassembled, and all parts are thoroughly steam cleaned preparatory to inspection and repair.

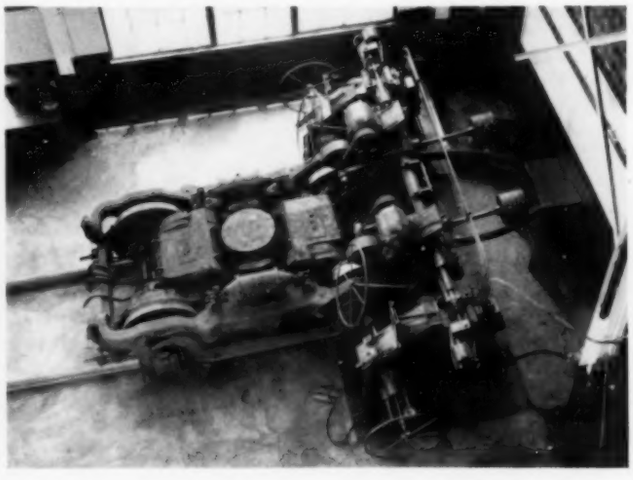
If the engine is of the type with the crankshaft supported by the bed plate, this unit is, after inspection for cracks and other defects, set up on a large planer or milling machine and a cut taken at the parting line between the bearing saddles and caps to correct the worn condition of these faces, and to provide for the application of a fixed steel shim about ¼ in. thick at this point. This cut will be slightly less than ⅛ in. The caps also have the same amount removed from their parting line faces. Needless to say we do not have a planer with a bed large enough for this operation, so this job is sublet.

The next step is to lower the bed onto a set of heavy steel parallels (Figure 7) where it is shimmed and leveled with great care. We consider these parallels to be of great importance if the repair to engines of this type is to be undertaken. Ours are fabricated from very heavy H columns, stress relieved, and securely anchored to a 40-ton block of concrete.

A precision ground, heat treated, cast iron arbor (Figure 8), finished to a size 0.001 in. smaller than the bearing bore diameter, is used with blueing to determine the bore alinement and size. This is then corrected to a high degree of fit by hand scraping. The caps are also fitted to the same arbor, and are then installed on their respective saddles, and the hold-down bolts torqued to the correct tension. The vertical diameter of the bores are measured (Figure 9), and the difference between this measurement and the correct size, determines the exact thickness of the fixed steel shims. These are sawed from commercial flat stock, drilled for fastening screws, ground to a precise thickness and securely fastened to the bed. The caps are reapplied and the bore dimensions checked. This measurement is held to minus 0.000 in. plus 0.001 in. This method provides for doing a good, accurate job with a minimum of expensive machinery.

The next step is to polish the main journals and crankpins of the crankshaft. We do this on a large lathe, but it can be done by hand nearly as well. If the surfaces of these journals are smooth and polished, without any evidence of galling, and are less than 0.002 in. out of round, taper, or total wear, we reuse without having

Figure 6 — A wheel tread and flange grinding machine is used which can quickly restore wheel contours. This machine is rather unique.



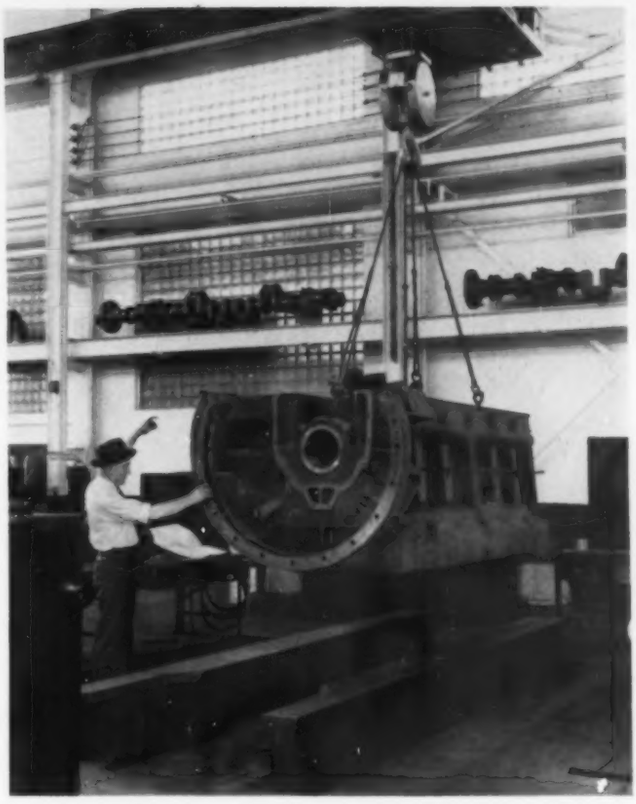


Figure 7 — Heavy steel parallels are an important tool in the repair of the engine.

the shaft reground to an undersize.

A well designed and built, well cared for engine frame, or block, will usually require minimum expenditures during a heavy overhaul. After cleaning, careful examination is made for cracks, the liner seats are lapped, and, if the frame carries the cooling water, these water contact surfaces are painted with several coats of special paint. If cracks are discovered in a fabricated steel frame, these are cut out and welded, using a soft steel coated electric welding rod. Each pass is peened with a chipping gun, and the welding current is held to a minimum to keep the work relatively cool.

Cylinder liners are reapplied at the time of overhaul, if the wear at the top of the ring travel is not more than 0.002 in. per in. of diameter. All liners have the upper ridge removed, and receive a light honing to break the surface glaze. Our present experience has led us to use only high quality, homogeneous, heat treated, cast iron liners without any special surface treatment, except an application of the same paint on the water side of the liner as mentioned for use in frames. However, in the near future we will experiment with chemically treating the wearing surface of the liner to improve the anti-scuffing properties during the breaking in period.

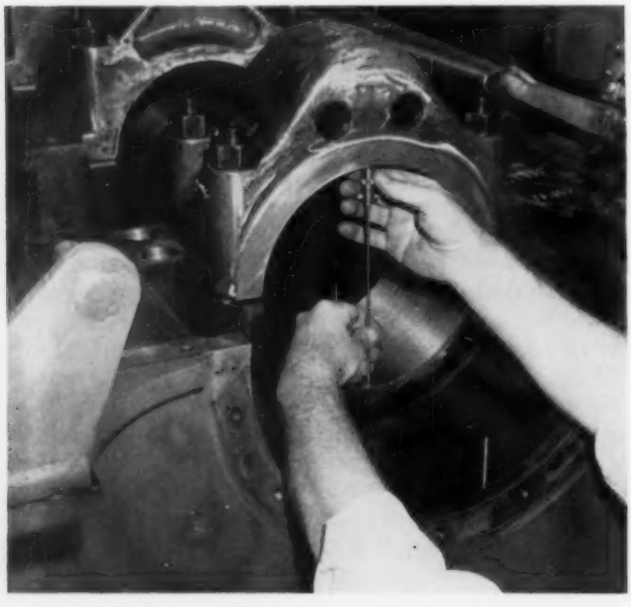
Aluminum piston repair is usually one of ring groove dimensions. Under normal wear we will open up the top compression ring grooves when the side clearance exceeds the original dimension by 50 per cent. Two sizes of overwidth piston rings in steps of $\frac{1}{32}$ in. will accommodate this increased width. If grooves and lands are beyond repair by turning, our shop has welded many pistons by using home made sticks of aluminum poured from scrapped piston material, coated with flux, and

Figure 8 — An arbor is used to determine bore alinement.

deposited by a carbon arc. Before welding, the broken lands are removed in a lathe, and the piston is heated by gas to about 500 F. This results in a dense, porous free weld of about the same hardness as the original piston. Before installing piston rings, the end gaps are gaged in a cast iron ring fixture bored to exact cylinder size and provided with a shoulder, in order that the ring will be positioned square before gaging. See Figure 10. We hold a minimum gap of about 0.004 in. per in. of cylinder diameter.

Large cylinder heads require several operations to rehabilitate them for service equal to new. Our first operation, after stripping and cleaning, is to inspect visually for cracks. A water test at 150 psi is then applied to detect cracks or porosity that will result in water leaks. The flange that bears against the head to liner gasket is examined for surface defects that may result in gas blows, and, if present, the entire face of the head and flange is remachined. This operation does not change the cylinder compression, but, will bring the injector tip further into the cylinder away from the face of the head, resulting in a change in firing pressure if not compensated for. This reduction in depth of the injector seat from blueprint size is measured by a plug gage and depth micrometer. To bring the injector tip to the correct position within 0.005 in., thin steel washers are placed under the copper nozzle gasket in number sufficient to compensate for the loss in seat thickness. A notation of this dimension is recorded on a brass plate fixed to each head.

Figure 9 — The vertical bores are measured to determine the thickness of the steel shims.



The valve guide condition as to wear or scuffing is noted, and they are replaced if worn more than 50 per cent over the original clearance. To handle heads weighing around 500 pounds, we use a stand (Figure 11) built up from two discarded connecting rods, a freight car axle, and suitable brackets to which the heads are fastened. This positioner enables the worker to manipulate the head into any position with great ease and safety. Spindles are installed in the valve guides, and the seats are ground with an eccentric valve seat grinder. The seats are then narrowed to the required width by reaming or grinding.

Valves, after inspecting for cracks, are refaced in a single purpose grinder which insures circularity of the seat, concentricity between seat and stem, and a high finish on the valve face. Both valve face and seat are finished to the same angle, as we have been unable to find any advantage in the interference method of assembly. Valve springs are tested for deflection by loading with a 150-lb weight (Figure 12), and referencing the deflection against our standards. Compensation for the removal of valve, and valve seat material in one step of $\frac{1}{8}$ in. is made by installing special washers under the valve springs. Valves are assembled into the head without lapping, as we have found that with an accurate grinding job that lapping is entirely unnecessary.

Before passing from the subject of cylinder heads, we would like to describe one example of the method we use to repair cracked, cast iron heads. The example selected, is equipped with a single pair of valves, and is constructed with a cast-in combustion chamber. Cracks developed at the throat of this combustion chamber on the edge toward the air valve, and had penetrated for a depth of perhaps $\frac{3}{8}$ in. To repair, we proceed as follows: First, we mill out the metal and cracks around the elliptically shaped throat of the combustion chamber to a depth of about $1\frac{1}{4}$ in., and to a width of about $\frac{5}{8}$ in. for the full circumference. A short piece of seamless boiler tubing is then shaped to the form of the throat with the inside diameters the same (Figure 13). Four guide wires are tacked to the inside of the tube, and extend down in the combustion chamber throat to hold the tube in position during the brazing operation to follow. The head is placed in a small gas furnace, the temperature is brought to and held at approximately 1000 F, and cast iron gas welding rod with flux is deposited by an acetylene torch. The head is permitted to cool slowly to room temperature, after which it is remachined. The new steel combustion chamber throat is hand ground and polished, the guides are reinstalled, and it is ready for service.

Concerning connecting rods, we would like to mention one check that is generally overlooked in many shops, and that is the presence of twist or bend in the shank

Figure 10 — End gaps are checked by using a cast iron ring fixture.

of the rod, making the geometry of the two bearing bores unsatisfactory. To check this condition, an expanding dummy wrist pin is fitted to the upper end, and a tightly fitted half cylinder is clamped by means of the rod cap bolts to the lower end of the connecting rod. The wrist pin arbor is then supported by two precision vee blocks on a surface plate. The lower end of the rod is held clear of the plate by the point of a small cone. A precision square is brought against the machined faces of the lower end of the rod, and the twist is measured with feelers. We allow a maximum of 0.002 in. A fixture, equipped with a dial indicator, is used to measure the distance between the two arbors on both sides of the rod. This difference is held to less than 0.002 in. See Figure 14. To correct rods over our tolerances, we twist or bend the rod cold with a press and other gear. However, no attempt is made to straighten rods that have been damaged due to abnormally imposed stresses.

To receive satisfactory service from the connecting

Figure 11 — The stand has been improvised from discarded equipment.

rod and main bearings in an engine, three conditions must be fulfilled: (1) The type of bearing must be adequate for the loads imposed on it; (2) the condition of the rods, crankshaft, and bed alinement must be good; (3) the lubricating oil must be present in adequate supply, and must be free from all abrasive material.

Engines built for railway switching service fifteen to twenty years ago were slow turning, low power, heavily built machines intended for intermittent output of rated horsepower. They were invariably equipped with babbitt-lined bearings with a lining thickness of about $\frac{1}{32}$ in. This material was cast on steel or bronze shells in some engines, and in others the overlay was made directly on heavy cast iron bearing blocks. Loads seldom ran over 1600 psi, and both bearing and shaft life were generally considered satisfactory. Today, some builders are still trying to use the same bearing materials in engines where the loads are twice that encountered in older engines. The low cost, good surface action, embedability, and conformability of a thick babbitt bearing, coupled to a wide spread impression that hard bearings and soft shafts make an undesirable combination have influenced some builders to persist in attempting to use this type of material in high capacity engines. The result has been, that the user is forced to inspect and replace bearings with great frequency, if serious troubles are to be avoided. To overcome this fault, we are trying out bearings of the tri-metal type consisting of a steel back, metallurgically bonded cast copper-lead, and a thin precision, electroplated lead-tin overlay. These bearings were applied to engines with shaft hardness of about 210 brinell. The experience to date, after 25,000 hours service on each of four engines, has been very satisfactory, as the shaft wear, both taper and out of round, is less than 0.001 in. and the bearings are in good condition with the 0.002 in. overplate on the loaded halves just beginning to wear off. Other engines with less hours of service show the same satisfactory condition. We are also about to test another modification of this same type of bearing, provided with a cast overlay of lead-tin 0.004 to 0.008 in. thick. This type should have adequate fatigue strength in the overlay, and will embed minute particles somewhat better than the first mentioned type.

To secure good results from even the modern high duty bearings, it is necessary that the bearing saddles be in nearly perfect alinement, and that the rod bores are round and parallel. Ways for achieving this have been mentioned. Precision type bearings have no shims, and in passing, it should be noted that no scraping or other modification of bearing dimension should be made prior to installation. After an engine is assembled and installed in the locomotive, we make a final check of this shaft alinement by means of a special dial indicator applied between the cheeks of each crankthrow. Readings are taken at each quarter while revolving the shaft through 360 degrees. On the top and bottom of the stroke, air pressure is admitted into the combustion space; after the shaft squeezes the oil from, and seats firmly on, the two adjacent main bearings, the deflection may be measured. Without air, our maximum tolerance for deflection is plus or minus 0.001 in., and with air, 0.0015 in. plus or minus the unloader reading depending on whether the crank is at the top or bottom of the stroke.

Figure 12 — Valve springs are tested for deflection by loading with a 150-lb weight.

The third precept of good bearing service is cleanliness. Every effort should be made to keep all metal or other abrasive material from the streams of oil that feed the bearings. As locomotive equipment, to do this job, we use a rather coarse strainer in the oil line just before the engine connection to take out material larger than 0.005 in.; and two bypass filters taking 10 per cent of the pump output and returning clean oil to the crankcase. Two other precautions are taken with rebuilt engines. The oil, as it is being pumped into the engine, is caused to flow through the external piping and radiators, and through the main bearing header with the bearing connection pipes removed. This provides a certain amount of flushing action, and cleans the lines of most of the detached particles. A magnetic full flow filter is temporarily installed in the oil line as near to the engine as possible for trapping magnetic matter down to 1 micron in size, during the break-in and testing period before dispatching for service. To recapitulate: for good service the bearing design and construction must be appropriate for the loads to be carried; the engine and its parts must be true, and in good condition; and, lastly, the oil must be as clean as it is possible to keep it.

Of all the parts of a diesel engine that require precision in manufacture, and care in handling, none are paramount to hydraulic relay governors and the fuel injection equipment. The repair of governors is a rather long, detailed process, the description of which would require too much time for the purposes of this paper, so, it will be sufficient to state that successful repair can be carried out in a small shop such as ours, with only one piece of equipment larger than a hand tool. This tool is a governor test stand, provided with a universal mounting table and drive spindle, an air motor for propulsion, a hand operated brake for loading the drive motor, and a tachometer drive. The terminal shaft or power piston clevis is mechanically connected to the air motor throttle, and, by hand manipulation of the governor speed control shaft, it can be put through its paces before application to an engine. To extend the life of such governors, before any repairs are necessary, is a matter of keeping the oil clean. If this principle is rigidly adhered to, these mechanisms will operate for several years without any other attention.

The fuel injection equipment on most makes of engines consists of a high pressure fuel pump, a high pressure fuel line, and a spray nozzle and holder. On some engines, the line is eliminated by combining the pump and nozzle in one unit, usually called a unit injector.

The function of the pump is to deliver a metered, timed slug of fuel to the pipe and nozzle. The time of the beginning and end of delivery is varied as the demand for speed or torque from the engine is changed. The repair of pumps is quite simple, in that it is mainly one of renewing parts. Very little salvage can be made of worn pump parts. Worn control rack holes in pump bodies can be bored out and rebushed; control gears can be turned 180 degrees, and reused if their slots are not worn; and delivery valves can be relapped to their seats if otherwise in good condition, Generally, however, disassembly and repair means replacement of such worn parts as may be found necessary. After a pump is repaired, it must be checked for a correct timing mark, and also for its rate of delivery at various rack settings under standard conditions. We mark all of our pumps for port closure with the plunger rotated so that a flat portion of the plunger end is just tangent to the upper edge of the barrel ports. This point can be determined with great accuracy as follows: the pump body is

Figure 13 — Cracks in cylinder heads are repaired in the shop.

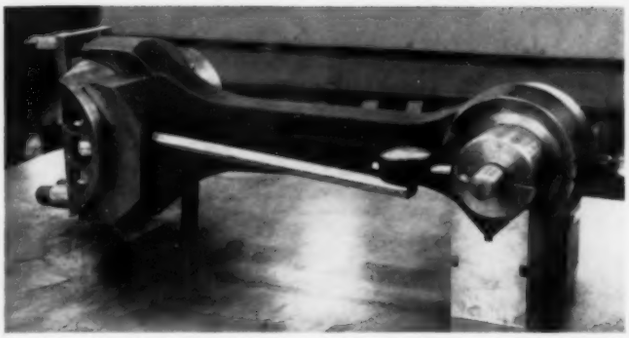
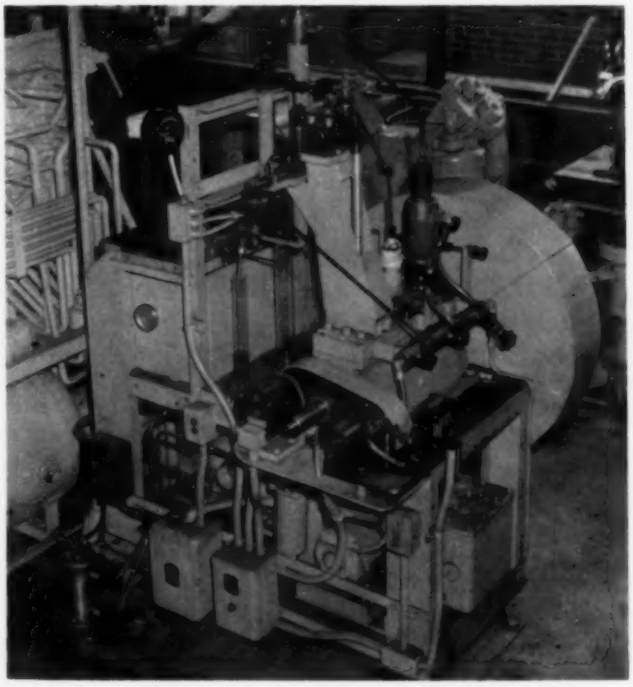


Figure 14 — The connecting rods are checked to determine if any twist is present.

fastened to a plate provided with a heavy screw threaded through the plate, and located under the pump so that, as it is screwed in, it will raise the spring cup and plunger. With a fine pitch thread, very small increments of plunger movement can be obtained per degree of rotation. The delivery valve, spring, and holder are removed and a dummy holder with a large central hole is applied. This permits access to the barrel cavity above the plunger for inserting a pea lamp at the end of an extension rod. The barrel locating screw is removed, giving visual access to the port and top of plunger. The latter is then raised until it just blanks the port, as indicated by the cutting off of light from the small lamp. Accuracy, within plus or minus 0.001 in. enables the repairman to check the timing marks in the inspection window with every assurance of being correct.

To measure the delivery from the pump requires a rather elaborate rig. The one we use is partly home made, and its reproduction is well within the scope of any job shop. Commercial devices of this type are available at considerable cost, and would only be

Figure 15 — Checking the delivery of the fuel pump requires an elaborate rig.



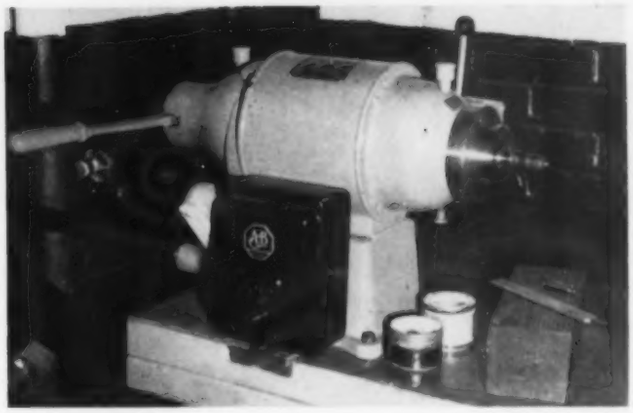


Figure 16 — A speed lathe is used to repair valve seats.

considered if a large volume of work is required. This equipment consists of a single speed motor driven camshaft and flywheel, a counting device electrically equipped to actuate magnetic fluid valves before and after a fixed number of camshaft revolutions, a source of temperature controlled (120 F) standardized fuel oil at about 30 psi pressure, fixtures for holding both standard jerk pumps and unit injectors, and glass graduates to measure delivery. To test, the pump is brought to speed, the fuel supply pump and fuel temperature control devices are activated, the counter is set to zero, and the graduate is placed under the delivery pipe from the three way magnetic valve receiving the fuel from the nozzle. During this warming-up period, the rack of the pump has been set at the highest of our standard settings which might be 25 mm on the control rack. A switch is then closed which simultaneously starts the counter and opens the fluid valve to discharge into the graduate. When the camshaft has made exactly 300 revolutions at a fixed speed, a switch in the counter operates the fluid valve, in order that nozzle discharge will once again be diverted back to the supply tank. The volume of fuel delivered to the graduate is noted, and if it varies more than 1 per cent plus or minus from our standard, the control rack is moved a few thousandths of an inch and the test is repeated. Upon satisfying this requirement, the control rack pointer is reset, and delivery readings are made at four other rack settings. Accuracy at these values are dependent on factors beyond our control, and are made primarily to check for possible faults in construction. When applying pumps to an engine, it is very important to have all the pumps timed the same within less than ½ degree, and that the control racks be set within less than 0.005 in. variation, one with another. Smooth engine performance and balanced firing pressures are largely dependent on these settings.

The function of the spray nozzle and holder is to direct the measured quantity of fuel received from the pump into the combustion chamber in a definite spray pattern, and with sufficient penetration into, and dispersion through the air mass, to produce the most efficient engine performance. The most critical part of this piece of equipment is the valve and its seat, the body and its seat, and the orifices in the hole type nozzles generally used on large railway engines. The valve seat and body seat are originally ground to

Figure 17 — An otoscope is used to inspect the body seat.

slightly different angles so that there will be a line contact between the two pieces. The valve seat has the greater included angle. The latter is harder than the body seat, and will require no repairs if it is to be reused. If the valve is damaged, the assembly is beyond repair in a railway shop. However, if the units are removed after about 8000 hours of service, and the body seat is relapped, the limiting factor for rejection will generally be wear of the multiple orifices. The tools necessary to rework the body seat are; a collet equipped speed lathe turning at about 1700 rpm (Figure 16); a hardened steel body cast iron insert lapping arbor; fine lapping compound; tallow for lubrication and cleaning; and a number 6 cut Swiss pattern file. It is beyond the scope of this paper to go into too many details, but in general, the process of restoring the body seat is to match the seat angle with the lap angle by examining the markings left on the lap by test trials, and, if necessary, altering the lap angle by hand filing. With the correct angle established, the seat is then lapped until it is smooth and without blemish. Examination of the arbor tip, and visual inspection of the body seat with the aid of an otoscope (Figure 17), will indicate a successful conclusion to the job.

Before passing to the last subject, it would be well to mention one item about testing the pressure setting of nozzles. The customary setup is a hand actuated jerk pump, a line with pressure gage, and the nozzle to be tested. The mechanic operates the pump handle rapidly, and tries to read the gage with the hand fluctuating violently, often resulting in a setting that may be incorrect. To overcome this difficulty, we install in the line, a volume displacing means made from a steel block valve with the spindle seat cut off. When in use, the valve handle is screwed out to the limit, the pressure in the line is pumped up to within less than 1000 psi of the nozzle setting, and the valve needle is slowly screwed in. The pressure will rise gradually until the nozzle valve lifts, enabling the operator to read the gage with ease and accuracy. A further benefit is derived from the use of this valve, in that it is easy to detect nozzles that leak at a very low rate; the pressure simply refuses to rise, the valve will not release, and dribbling will be observed.

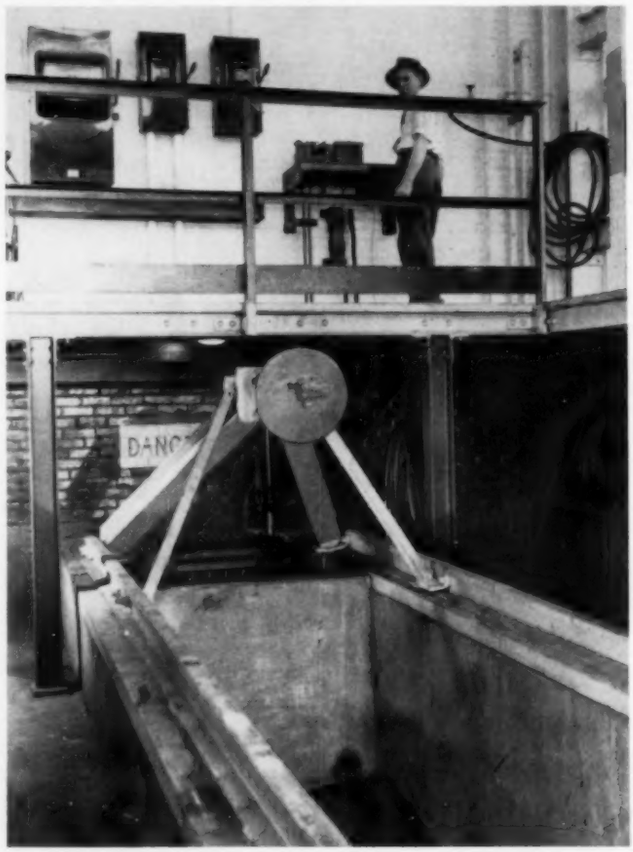
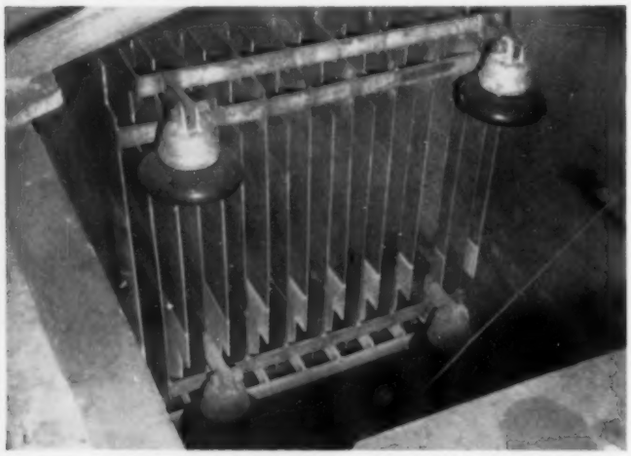


Figure 19 — Water box used in testing generators.

After an engine has been overhauled, and at intervals of about 8000 hours or each year, the generator should be coupled to an artificial load for checking the power plant performance and condition. There are, at least two types of loading equipment in general use; the water rheostat, and the blown grid resistor type. We use a

Figure 18 — The generator performance is checked through the use of a water rheostat.



water rheostat (Figure 18) because of its simplicity, low cost, and the infinity of loading steps within its range. Our plate assembly is made up of nineteen ¼-in. stainless steel plates, each measuring about 3 ft by 3 ft, and spaced at 2 in. center to center. Each of the two pole groups are tied together by welded pieces of 2 in. by ½ in. flat stock at or near the plate corners, and the two groups are separated electrically and mechanically by eight high voltage line insulators. This assembly is located on a pit floor at the wall end of one of our track pits under the deck level work platform crossing the pit. See Figure 19. A concrete dam, and the leanto wall form the balance of the box to contain the water used as electrolyte. This fresh drinking water, carrying enough dissolved solids to make an adequate electrolyte, is brought to the box through a 2 in. brass pipe located in a horizontal position on the pit floor against the back wall. This pipe is drilled with a multiplicity of ⅛ in. holes so that the flow of water will be distributed across and through the plate group. The water level, and consequent load, is maintained by the location of the open end of a 6-in. pipe which is free to move in a vertical arc about a ball bearing, flexible elbow whose outlet is cemented in the dam at the lower corner formed by the pit wall and dam. The movement of this pipe is controlled by a small hand winch at the meter table on the deck level platform immediately above the rheostat. Movement of the winch is imparted to the free end of the water egress pipe by a simple wire and pulley system. The water level can be varied for the full height of the plate assembly. The relationship of plate area, spacing, and water conductivity of our equipment is such that we can adequately load and test any locomotive up to 1500 hp. It should be remembered, before proceeding with the design of this type of box, that the available water supply should be tested for resistance per unit volume to determine the plate area and spacing. Our experience indicates that a spacing much less than 2 in. is undesirable. Besides the rheostat just described, the following meters are needed to check output and engine performance: a 2000-amp capacity ammeter and a 1200-v voltmeter, a 150-v voltmeter for checking battery charging generator voltage; a hand tachometer (Figure 20) for engine speed; a maximum firing pressure indicator for compression and firing pressures of each cylinder; a set of thermocouples and pyrometer for exhaust gas temperatures, and several all-metal thermometers to measure oil and water in-and-out temperatures.

We have arranged some details of our electric transmission circuits, so that connecting up a locomotive is only a matter of minutes. Our load leads are made up of two 400,000-cm cables on each side of the circuit. Due to the considerable length of these lines, and the appreciable voltage drop at heavy loads, we have separate high voltage leads connected directly to the main generator for our load voltmeter.

After checking the no load, idling and full speed of the engine, and the auxiliary generator voltage, we begin to record the generator kilowatt output, starting with 0 amp and continuing up to about 1400 amp with 1000 hp engines in equal increments of 100 amp. The engine speed and injection pump control rack positions are read coincident with the meter readings. After this data is checked and adjustments corrected, if necessary,

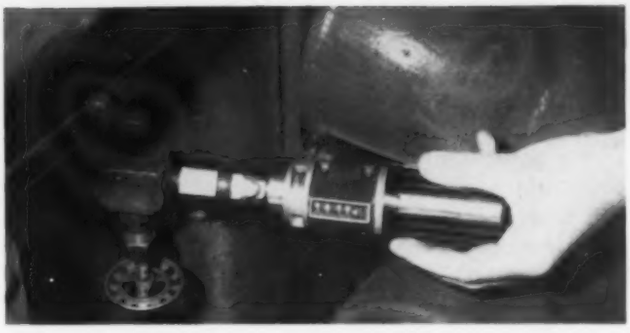
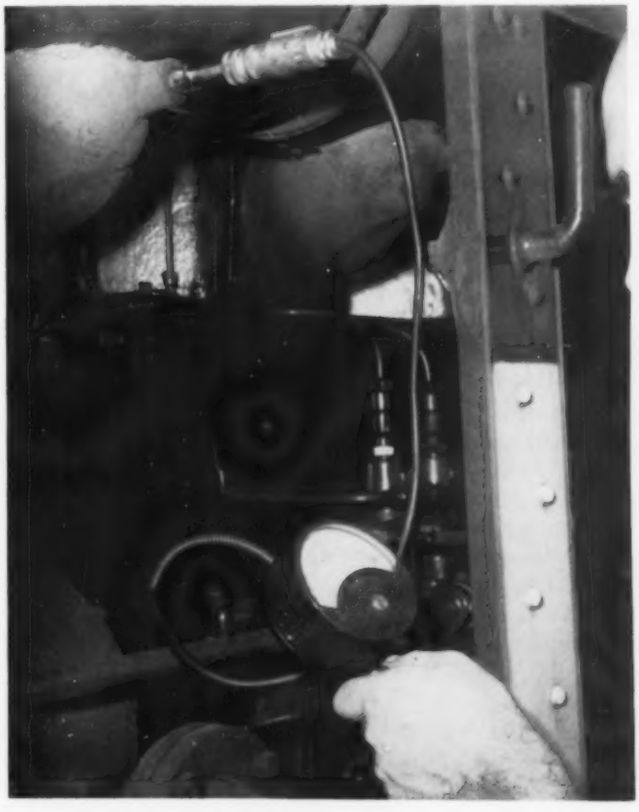


Figure 20 — A tachometer is used to check engine speed.

we then take readings of the full speed compression pressures of each cylinder, at full load on supercharged, and at no load on normally aspirated engines. On a newly erected engine we accept a variation of not more than 4 per cent plus or minus the norm of all the cylinders. With the engine running full speed, full load, maximum firing pressures are read, and exhaust gas temperatures noted. We apply the same limits of 4 per cent above or below average to firing pressures, and also to the exhaust temperatures.

The repair and modification of diesel locomotives, in all of their ramifications, is far beyond the scope of this paper. We have picked these few high spots as typical of the type of operations and tools that are necessary to keep a moderate sized fleet of hard worked diesel-electric switching locomotives in good condition. The slogan for this type of work could be: "*Whatever is worth doing, is worth doing well.*"

Figure 21 — Through the use of the instruments, complete data is obtained on the firing cycle.



DISCUSSION

PRESENTED BY

ALBERT HOEFER, Baldwin Locomotive Works, Philadelphia, Pa.

FRED SCHOEN, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

HENRY C. JONES, Assistant Superintendent, Patapsco & Back Rivers Railroad Co., Sparrows Point, Md.

A. E. CICHELLI, Lubrication Engineer, Bethlehem Steel Co., Sparrows Point, Md.

CARL A. JACOBSON, Consulting Engineer, Ardmore, Pa.

H. K. HARDCASTLE, District Manager, Electrical Controller & Manufacturing Co., Philadelphia, Pa.

A. J. FISHER, Assistant Chief Engineer of Construction, Bethlehem Steel Co., Bethlehem, Pa.

JOHN S. MORRIS, Superintendent Maintenance Control, Lukens Steel Co., Coatesville, Pa.

NORMAN C. BYE, Director of Engineering, Henry Disston Sons Co., Philadelphia, Pa.

Albert Hoefer: What is your experience in the use of reclaimed oils, exclusively, in engines?

Fred Schoen: Maybe Mr. Jones was lucky enough to convert from steam to diesel overnight. We are not. We have had considerable difficulties with the steam mechanics as well as with the diesel mechanics. There are some steam men that do not want any part of a diesel, and some diesel men who do not want any part of steam, and when you try to have them together in the same shop it does not work. I would be interested in your comments on how you contrive to switch over, to really get men on the new diesels and at the same time perhaps break in some of your steam men to the diesels.

You had, I believe, five men on one shift and about three men on the day shift, servicing and maintaining. I expect that is exclusive of the men running the machine tools?

Henry C. Jones: That is right.

Fred Schoen: With your switching service, do you have many locomotives out of service, shall we say, from 12:00 at night until 8:00 in the morning, or are your locomotives all in full 24-hour service? That makes some difference in the set-up of your maintenance time, and while it is very desirable to do your maintenance on the locomotives when equipment is down, it also brings in quite a supervision problem.

A. E. Cichelli: Will you please elaborate upon the development work, and experience encountered in developing suitable oil filters? Also, how much additive has to be replaced in the re-refined oil?

Carl A. Jacobson: It happens that I have been in the diesel engine business from the very beginning in one capacity or another. I happened to have tested the first diesel locomotive on the New York Central, the first in this country. I have been with some of the diesel builders and locomotive builders, such as Baldwin and have helped to develop some things and methods that have been used. Therefore I have been interested in the improvements in maintaining diesel locomotives.

I want to compliment Mr. Jones particularly on the completeness of his shop and equipment, as well as his original thinking on some of the things that he has done.

Many of you who are not familiar with the subject or who have not been around diesels much except to hear them puffing and smelling the fuel odor, sometimes do not realize that some of the things that Mr. Jones has done are not found in all the shops. The wheel grinding arrangement is something he has developed on his own, and a lot of people could probably take it up and find it would save a great deal of time and labor.

I have no particular other points to bring out, except to say, that on the small road, a great many of the things that he has done could be followed to advantage. Also the larger roads, beset with problems that are due to the greater magnitude of their operations, could benefit from some of Mr. Jones' ideas. A lot of times things must be done in a hurry, and particularly where there are people not too well trained and where operations are not under good men, there are many difficulties. A great deal has been done but there is room for further improvement.

H. K. Hardcastle: I notice there are motors and generators on these diesel locomotives. Presumably they also have control, although nothing has been said about it. I would be interested to know what provision has been made to take care of the control on these locomotives.

Member: You spoke of fortification of the lubricant with additives. I was just wondering what that makeup is, percentage-wise, and what types you have to put in.

A. J. Fisher: I wonder if Mr. Jones will state what the availability factor is on his engines? I think he ought to give us an overall figure on how they perform. What percentage of the time will they do what he wants them to do?

John S. Morris: May I ask a question concerning the economics of rehabilitating the oil instead of using new oil?

Member: Do I understand you take them off every so many hours and go over them completely, or do you wait until you develop mechanical trouble before you give them a thorough inspection?

Norman C. Bye: I would like to ask a question on this paper which covers a subject where a user has developed a method of investigating and correcting troubles on a relatively new product. I would like to know whether your technique and procedure of care and maintenance of diesel equipment were the result of the manufacturer's recommendations or were they specifications and practices you developed yourself as a result of operating experience?

Henry C. Jones: The first question was on the use of reclaimed oil in engines. We normally reclaim all of our used engine oil. The yield is about 80 per cent of the volume drained. For every barrel of the reclaimed oil, we have to add two barrels of new oil in order to have enough to take care of engine requirements. The individual locomotive demand is about two gallons per 24 engine hours. In other words, an engine in service for a month, which is around 720 to 744 hours, will use about 60 gallons of oil. Our observation has been, that a good oil, properly reclaimed and refortified with

detergent and oxidation additives, is, for practical purposes, nearly as good as new oil. It is probably not as stable as the new oil, but from our viewpoint that is more or less a theoretical fault.

Mr. Schoen, your question concerned changing from steam to diesel operation. Without going into details, we had a very easy job. This shop was built in the latter part of 1946. The maintenance of our locomotives, both steam and diesel, was taken care of by another firm, prior to that time. Shortly after we took over, we completely eliminated the steam locomotives. At the time of establishing our organization we were fortunate enough to be able to select the personnel with great care. Probably thirty per cent of the men formally worked on steam locomotives; the balance were young men that we picked up, largely, ex army and navy men. We place great emphasis, when we hire a man, upon his attitude toward the job. I am not a psychologist, but I place great store on the man's interest and ambition, rather than any very extensive background. In this shop, and others with which I have been associated, we have been successful by taking younger men with at least a high school education, that want to work at a job.

You spoke of locomotives out of service. We have 33 locomotives. We run 28 to 30 crews around the clock. That is the normal demand, which leaves 3 to 5 locomotives for repairs or service.

As I said in the paper, we like to rebuild every locomotive on an average of about every 8 or 9 years. Therefore, we have to completely overhaul 3 to 4 locomotives a year. A small gang does this work, and one unit is always undergoing heavy repairs. There is also one locomotive being inspected for ICC requirements on the day and middle shifts. The group I referred to in the first part of the paper is strictly monthly inspection, and does not include heavy repair men, machinists, sheet metal workers, and people like that. The other one or two locomotives we use for servicing the machines that are in service. That is, rather than have the crew bring their locomotive to the service station, we have hostlers take a locomotive to the crew, bring their engine back, service it, and return it to them.

The filters are nothing particularly original with us. The fuel oil filters we use, which filter particles down to about 5 microns in size, are located on the suction side of the transfer pump. We use these rather than the conventional edge strainer at this point. As long as we are going to maintain filters, we might as well filter the oil through the transfer pump as well as the fuel injection pumps. The filters shown on the screen were the type of cartridge we use, which lasts three months without changing, or, the equivalent of about 2200 hours. This is inexpensive filtering. As to the lubricating oil by-pass filters, they are conventional. Most people use more than two. Our experience indicates that nothing will be gained by putting more on. The edge type strainer which handles the entire oil flow through the system will stop particles larger than 0.005 in. The magnetic filter is used as a result of a suggestion made by Mr. Jacobson. It is installed during the run in period after an overhaul, and does a good job at removing material larger than 1 micron.

Mr. Hardcastle asked about control equipment. Very little was mentioned in the paper on relays and switchgear, because most equipment offered by manufacturers is good, and presents very few maintenance problems. I might mention that for switching work we favor control circuits that permanently connect the four traction motors in two parallel groups of two motors in series, if the main generator has sufficient current output at zero voltage to realize full tractive effort. Our speed requirements are such that we do not require or use any field shunting equipment. We keep only such devices on our locomotives that are useful and necessary for good service.

Mr. Fisher asked about the availability of locomotives. I would say that 90 to 92 per cent would be an average figure. There are 28 to 30 always running, and the balance out of service.

Mr. Cichelli asked about the cost of reclaiming our oil. It costs about half as much as new oil. It is worth doing. We have a natural repugnance to throwing something away that looks as if it might be useful, and we would not know what to do with the barrels of used oil if we did not reclaim it. You can use it in journal boxes, but, you cannot use it up fast enough. As to the manpower requirements for this job, the one man we use also does other jobs requiring his presence in the same place, so while he is waiting for the oil to cook, he can be doing something else that is useful.

The question was asked if we overhauled at regular intervals, or only when troubles developed. Normally we completely rebuild a locomotive after eight or nine years of service. This includes all assemblies. On heavy four cycle engines, we renew the engine bearings and rework the pistons, heads and liners at about four year intervals. On lighter two cycle engines this latter work is done at three year intervals. Other work is done if the need develops during these periods as required.

To answer Mr. Bye's question: We have had many good suggestions from manufacturers, which, we in turn have either used as suggested, or as the basis of some better idea. I would be rather bold if I stood here and said, "Yes we think of everything." We do not; most developments are the result of community thinking and suggestions, and a willingness on the part of management to go ahead on things that look worthwhile. The people in our shop have thought of many ideas, and we are always receptive to their proposals.

I might say, in closing, that I would not want to leave the impression with those contemplating the purchase of this type of power, that it is necessary to invest large sums of money equipping for maintenance. That would be incorrect. It is perfectly possible, with a small group of locomotives, to get along with a small shop, and farm a large portion of the repairs out; injection equipment, electric switchgear, motors, generators, cylinder heads and so on can be returned to specialty shops, who will unit exchange or repair and return the piece. This is undoubtedly the best system to adopt for those who are new at the matter, or have such a small complement of locomotives that they could not afford to invest in tools such as we have. However, an operation involving many units, coupled to a demand for heavy work with a minimum of engine failures, will be served best by a shop organization and equipment prepared to deal with most of the repairs that will surely be required.

Conditioning Surfaces
OF LARGE HOUSINGS IN PLACE

By E. A. BERRY
Superintendent of Machine and Forge Div.
Centralized Maintenance
Lukens Steel Co.
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. . . . the equipment described is a recent development which enables grinding and machining of large mill housings which cannot be readily taken down and moved to the shop . . . .

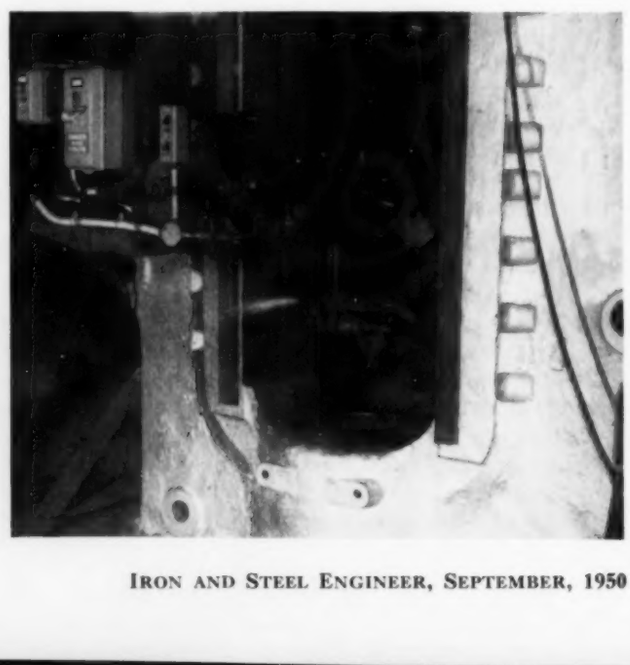
▲ IN the many and varied maintenance problems of hot rolling mills, adaptability of equipment plays a large part. In the maintenance of large mill equipment, facilities for repair, maintenance and machining often present many difficult problems. The machine equipment necessary for repair is either too small or too light to handle these heavy and bulky pieces of mill equipment or even portions of them. Machines large enough to perform the operations necessary, in most cases, cannot be purchased, nor for that matter can the cost of them be substantiated. Equipment of this size is repaired at such infrequent intervals that any large expenditure to perform these duties is quite impossible.

To overcome a necessary repair problem on mill housings of varied sizes, a member of our mill maintenance inspection personnel, designed, supervised the building and installed his idea to meet our needs.* This equipment has been used twice in the past year on a refacing operation of large mill housing stands. Housings vary in weight from 50 to 98 tons which explains the

*Patent application number — 116,195 dated September 16, 1949.

Figure 1 — Two grinders are set up to machine this 98-ton mill housing.

Figure 2 — A single grinder is being used to machine this 50-ton mill housing.



remote possibility of machining by any other means.

The operation of resurfacing of mill housings is necessary after long periods of use, to assure accurate operation and alinement, also to prevent breakage and excessive wear of mating parts. Normal wear takes place on attached wear plates, or window plates, but housings are distorted by constant wear and pounding.

Figures 1 and 2 show a general view of the housings and the installation of the housing grinders. Figure 1 is of a 98-ton housing showing installation of two housing grinders. Figure 2 is of a 50-ton housing showing installation of one grinder; two grinders, however, can be used in both operations.

These housings are resurfaced to original drawing sizes, making all parts, that fit in the assembly, interchangeable. All calculations for repair and determination of sizes can be made in advance, expediting repair parts and minimizing time for repair requirements.

These castings are steel castings and are resurfaced with nickel-chrome welding wire, making machining by

Figure 3 — Care must be taken in installing the equipment and grinders for the machining.

methods other than grinding very difficult. One-eighth in. of weld is needed at different times to resurface these housings to original sizes.

Under previous conditions of resurfacing with hand type air or electric grinders, 9.5 sq. in. of material were resurfaced to size per hour, with four grinders in operation. Two automatic grinders now remove 31 sq in. of material per hour with an average of 11,000 sq in. of surface finished per unit of repair.

Grinder mechanism and grinders are mounted on housings by means of straight edges which are bolted to housing in holes so placed that future use for reconditioning is possible.

Figure 3 shows installation of equipment and guides used on both large and small housings. Grinders can be positioned in all different manners so that adjustment of vertical heights of machine, wheel wear and most efficient operation can be obtained. Side wheel grinding, face grinding and adjustment for clearances can also be made.

Figure 4 — Grinder wheels may be positioned in the manner which will give greatest efficiency.

Figures 4 and 5 show several grinding procedures. The grinders, of electric and hi-cycle electric type, are used and positioned on a vertical slide similar to the cross slide of a lathe. This vertical slide is attached to a cross rail, or carriage, similar to a machine bed. Feed of vertical slide, either up or down, is governed by a screw with split nut and has 12 in. of travel. Infield of wheel carrier is also moved by a screw and nut with a ratchet type lock with adjustment calibrated at 0.005 per inch per tooth.

The complete vertical slide and carriage are actuated forward and reverse on the cross rail. This movement is controlled by the action of a unique air-actuated clutch. The clutch is operated by the piston in the air cylinder. In the piston position at each end of the cylinder, it causes a friction clutch drive of forward and

Figure 5 — Another set up for grinding is shown in this photograph.

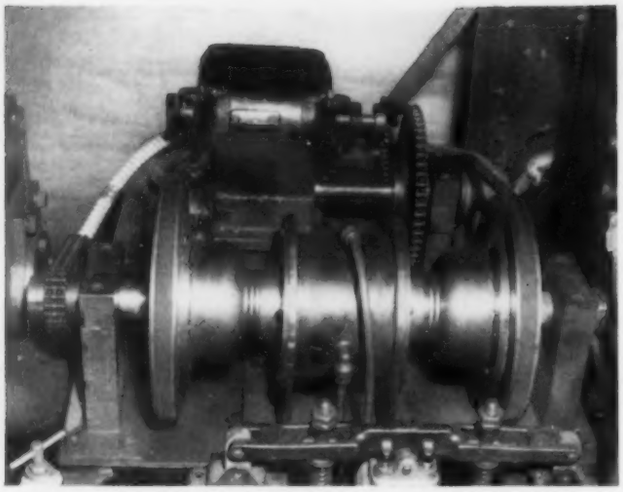


Figure 6 — An air-actuated clutch changes the motion of the grinder from forward to reverse.

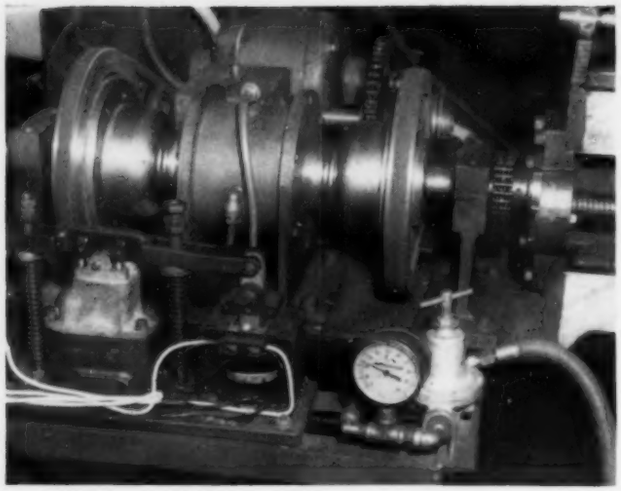


Figure 7 — Limit switches are used to actuate the solenoid on the four-way valve.

reversing pulleys. See Figure 6. The air pressure for movement of piston head is controlled by a solenoid operated 4-way valve.

Adjustable limit switches at each end of travel on the cross carriage actuate the solenoids on the 4-way valve (Figure 7). Operating pressure in cylinder is 25 to 30 psi.

Tolerances of finish housings have been very satisfactory in both cases. Parallelism of 0.031 in 18 ft was accomplished with a 0.011 differential in size on a 67.000 dimension. These fell well within the required blueprint specifications. By the previous method, tolerances were very poor.

This equipment has proved to be a great labor saver as well as a more accurate means of obtaining a satisfactory product. Costs have been considerably less than they would have been if special equipment had been purchased.

DISCUSSION

PRESENTED BY

L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Co., Sparrows Point, Baltimore, Md.

R. G. UHLER, Superintendent Mechanical Maintenance, Lukens Steel Co., Coatesville, Pa.

E. A. BERRY, Superintendent of Machine and Forge Division, Centralized Maintenance, Lukens Steel Co., Coatesville, Pa.

L. F. Coffin: We would be glad to know what total elapsed time was for welding and re-grinding a sheared plate mill housing and bringing it back to original dimensions. Am I correct in inferring from your illustrations that it is necessary to re-set the grinder every 12 inches of vertical feed?

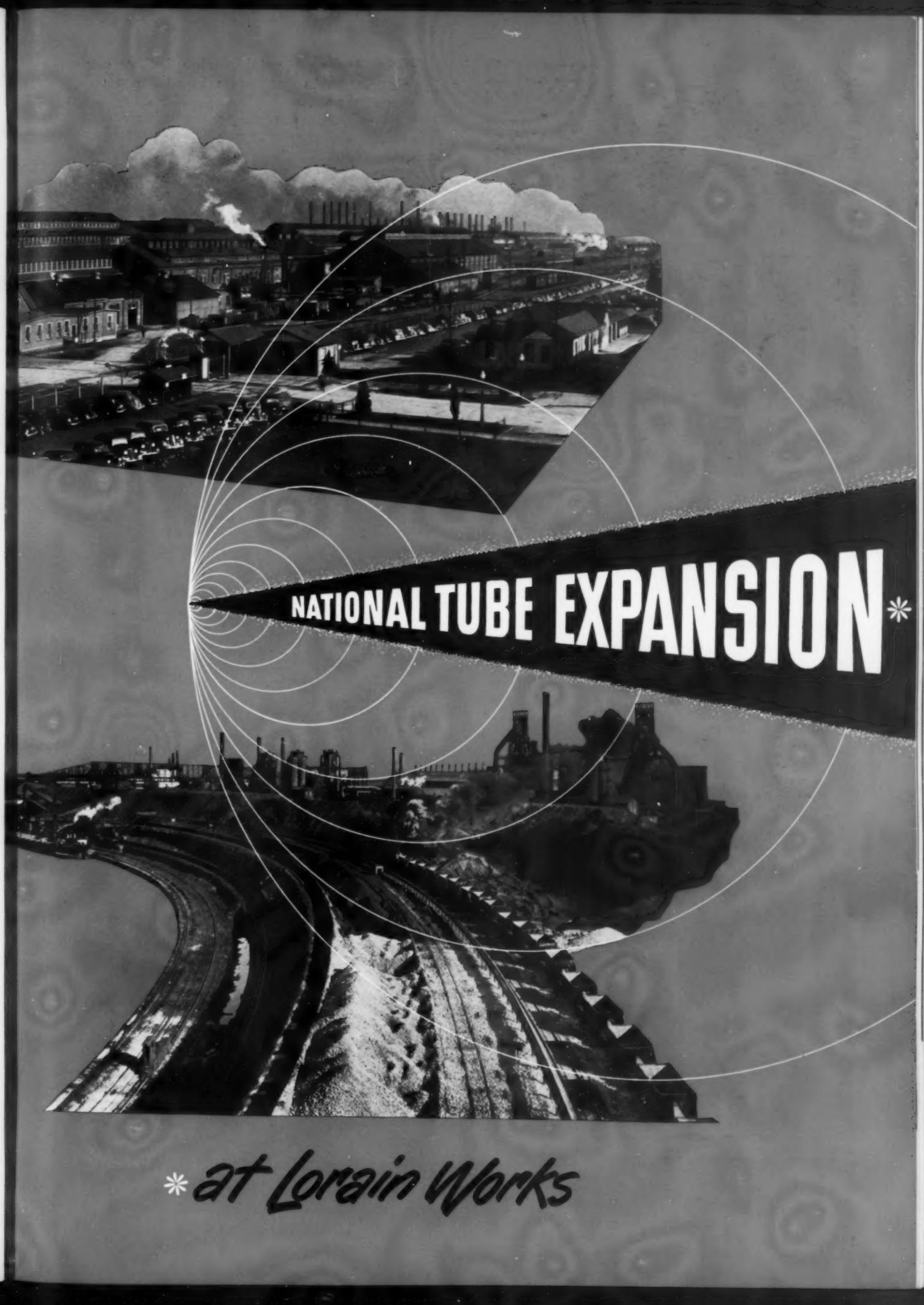
R. G. Uhler: On our smaller mills we usually carry one spare housing. Therefore, when we go down for a major repair we usually replace one of the worn housings and recondition the other one in place. We performed this operation in the last year on our 112-in. mill. The window plate faces on these housings are approximately 84 in. long by 20 in. wide. Depending on the wear, the welding time on these housings, with stainless steel rod, averages from 32 to 48 hours with the 48-hr period being the maximum time required. Grinding time depends upon the tolerance you wish to work, and to the skill and accuracy of the operator. During this repair we ground the housing for five 24-hr days and received wonderful results. The final tolerances were almost within those used in machine shop practice. The window plates and chucks were machined to predetermined dimensions and the mill was assembled to the tolerance desired.

During the recent electrification of the 206-in. mill, we reconditioned both housings. Since these are far too large to be removed they were necessarily done in place. Having plenty of time we did not press on this job. We welded all four faces almost completely and did grind them completely. The welding time with stainless steel rod amounted to seven 24-hr days. The grinding was continued for three weeks on an average of 18 turns per week. The windows and hook plates were machined to drawing size, and the chucks to a predetermined size. The assembled mill fitted up perfectly to the tolerances desired.

This grinder is a precision tool and not a hurry up tool. However, we feel there is still much room for improvement. We are experimenting with a grinder of greater horsepower and with different types of wheels. We hope to double, at least, the amount of metal removed in any given period of time.

I would like it clearly understood that this machine is not intended to replace flat surfacing in a machine shop. If the piece to be reconditioned can be removed quickly and machined efficiently in the shop, and then replaced easily, that is the way to do it. But, if the piece cannot be removed due to size, etc., or cannot be machined in the shop, then we feel we are developing the machine to do the job as quickly and efficiently as any machine available today.

E. A. Berry: On the question about movement of the cross rail up and down every 12 inches. That is done and they move up and down on the guides or side rails. These, of course, are counter-weighted over the top of the mill and they move easily up and down on the guide.


NATIONAL TUBE EXPANSION*
*at Lorain Works

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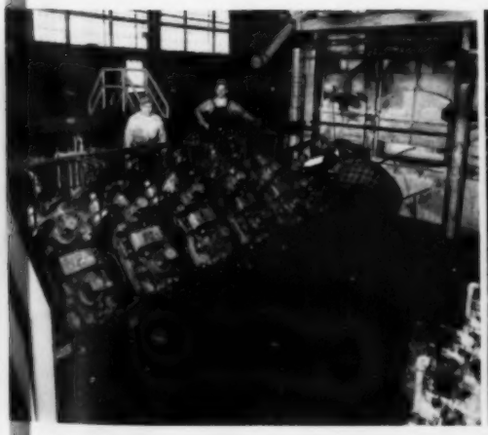
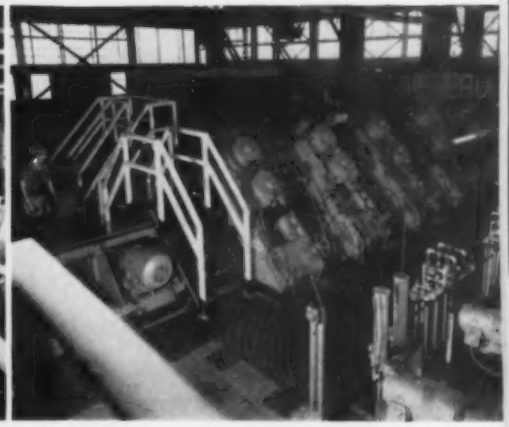
NATIONAL TUBE'S new continuous "Stretch-Reducing" SEAMLESS PIPE MILLS

designed and built by Aetna-Standard

National Tube and Aetna-Standard specialists have been working together for several years in the development of the world's first continuous seamless pipe mill now in operation at Lorain. A similar mill has been installed at Gary. These mills, based on the stretch-reducing principle, have been hailed as "one of the greatest advances in the steel industry during the past 50 years."

Aetna-Standard has been proud to work with National Tube in this accomplishment. This company builds most of the seamless tube mills in the world for pipe sizes from 2½" to 26".





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HANDLE ROUNDS FASTER...

SAFER...AT LOW COST

In National Tube Company's Lorain Works, these Heppenstall Tongs speed the job and reduce the cost of handling rounds at the blooming mill. No ground crew is required; the craneman merely positions the tongs and they perform the complete cycle of pick-up, carry, and release—automatically.

Heppenstall Automatic Safe-T-Tongs can be designed to handle any special shapes or weights. They replace chains, slings, hooks . . . eliminate accidents . . . save manpower, time, and money. If you have a handling problem, consider the efficiency of a Heppenstall Tong *engineered to your needs.* Write today for your copy of our new Tong Booklet.

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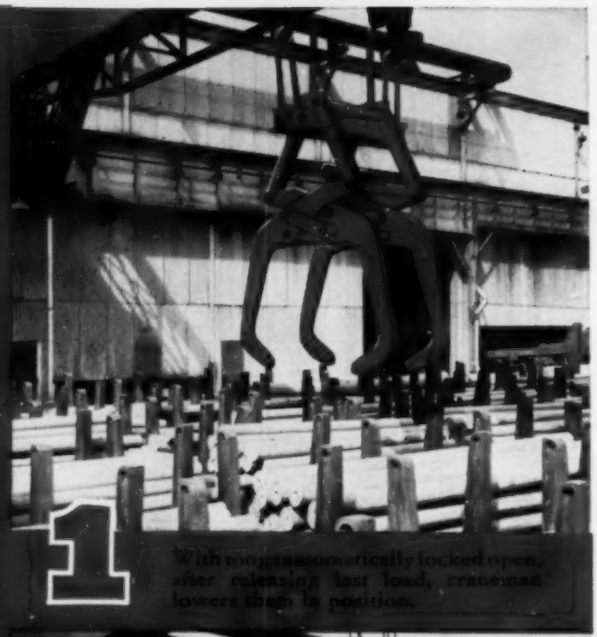
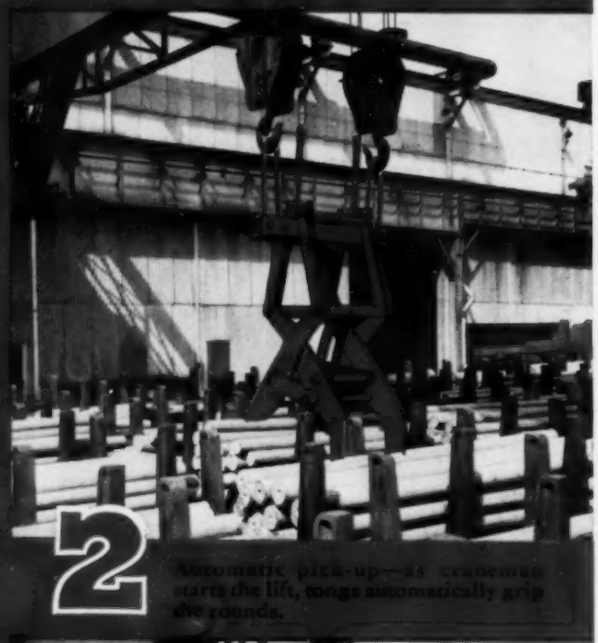
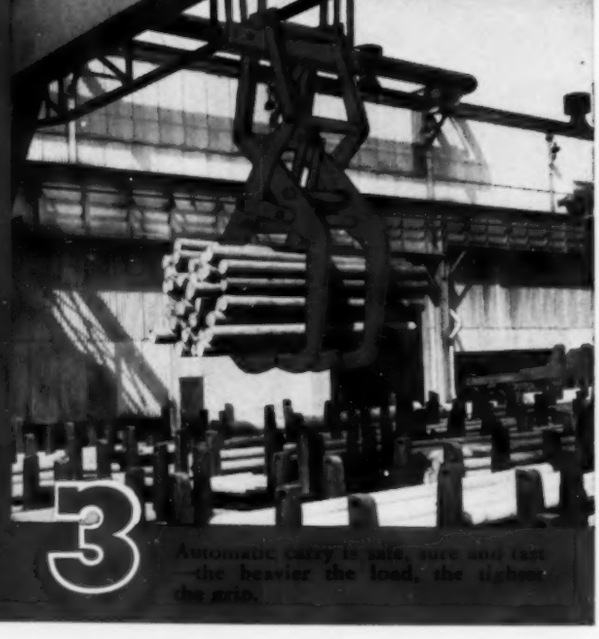


1 With tongs automatically locked open, after releasing last load, craneman lowers them in position.



2 Automatic pick-up—as craneman starts the lift, tongs automatically grip the rounds.



3 Automatic carry is safe, sure and fast—the heavier the load, the tighter the grip.

SOAKING PIT CARRIAGES AT THE LORAIN PLANT . . . BY "Shaw-Box"

When your Soaking Pit Carriages are "Shaw-Box," you have equipment assuring smoother operation; reduced impacts on the carriage, pit covers, and pits; and lower maintenance costs.

These advantages result from exclusive patented features found only in "Shaw-Box" construction. They include hoisting by means of eccentrics instead of the ordinary crank mechanism or hydraulic cylinder; spherical bearings on top and bottom of hangers, which allow lifting beams to thread into lifting tees; traverse motor and cross shaft inside girders to afford utmost protection to the driving mechanism; and a system of interlocks to give maximum safety.

Soaking Pit Carriages are a "Shaw-Box" specialty. Ruggedly built to exacting standards of fine engineering and workmanship, they give real performance with a minimum of attention. They fully conform to AISE specifications. For the greatest value in dependably superior Pit Carriage service your dollar can buy, look to "Shaw-Box."

BE SURE TO SEND ALL YOUR INQUIRIES FOR SOAKING PIT CARRIAGES AND CRANES TO "SHAW-BOX."

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MANNING, MAXWELL & MOORE, INC.

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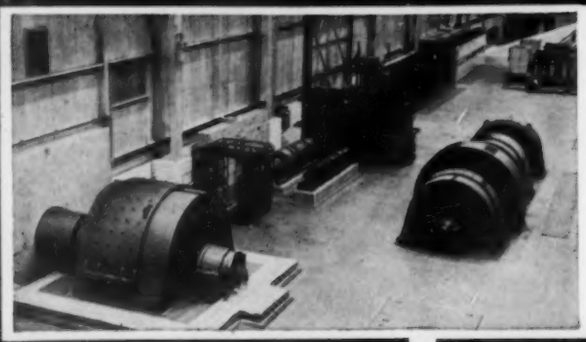
Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments.

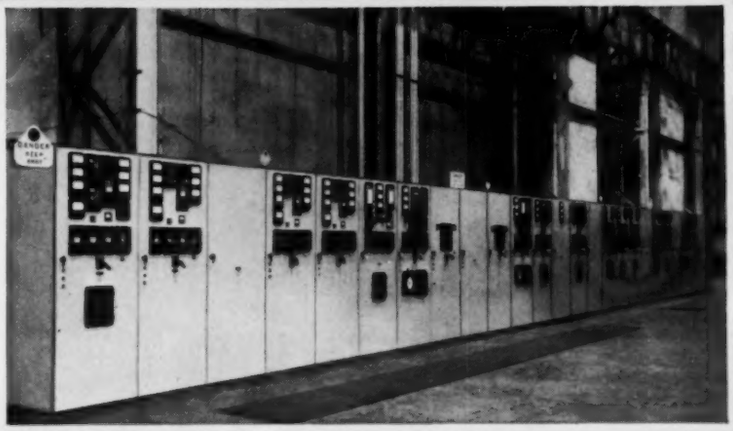


Direct from the 13,800 volt switchgear, power goes to the 4000 kw, 3 machine flywheel M-G set driving the 5000 hp reversing bar mill motor. M-G set, *Regulex* control, exciter set (behind motor), and motor . . . all Allis-Chalmers.

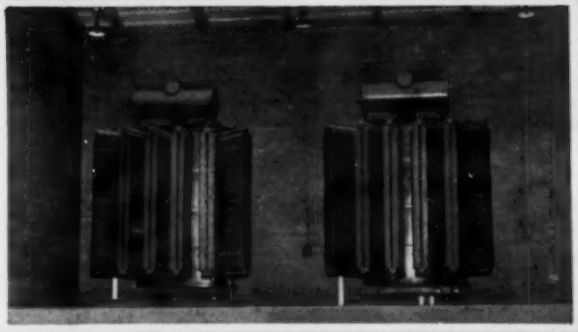
INCOMING
13,800 V

3 ϕ
60 ~ LINE

Allis-Chalmers switchgear controls all 13,800 volt incoming power. Exclusive metal clad switchgear with drawout, vertical lift air blast circuit breakers are used here for distribution and for controlling motor starting and dynamic braking. The starting reactors are in the basement under the switchgear.

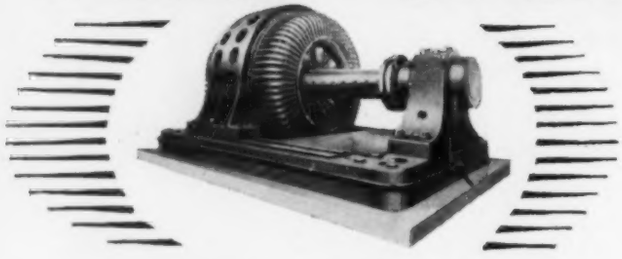


This outside bay of two Allis-Chalmers rectifier transformers steps voltage down for the 1500 kw mercury arc rectifiers providing 250 volt d-c mill supply. Transformers connected to rectifiers inside building by metal clad ducts through wall.



These two factory packaged heavy duty 1500 kw *Excitron* rectifiers provide 250 volt d-c mill supply. Heat exchangers built on rectifier frame. Anode breakers and transformers are at left, 250 volt d-c switchgear out of camera range at right.

Allis-Chalmers Guides



For 25 years Allis-Chalmers 800 and 1000 hp (shown above) synchronous motors have been in operation on the Lorain No. 1 seamless tube mill. These were the first synchronous rolling mill drives used by the U.S. Steel Corporation.

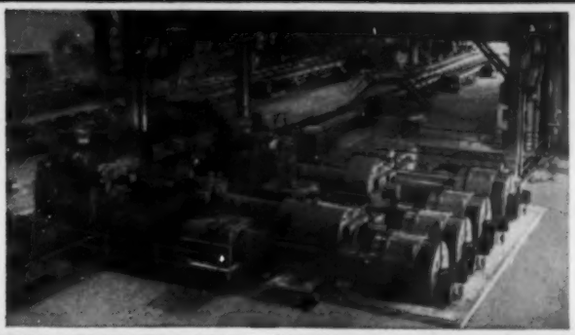
THIS PHOTO-SCHEMATIC shows the flow of power operating the entirely new Blooming, Bar and Billet mill at the Lorain plant of the National Tube company.

Feeders from the 13,800 volt switchgear go to the motor-generator sets for the separate mills, to the *Excitron* rectifiers providing d-c mill supply, and to transformers and switchgear providing general purpose 2300 and 480 volt a-c auxiliary power. *Regulex* control of the exciter

ALLIS-

Power, Electric,

Continuous billet rolling is begun in this 6 stand, close-coupled mill. Power at 13,800 volts is converted in the 5 machine, 8000 kw synchronous M-G set seen here. Six d-c motors of 1750 hp each, *Regulex* controlled, drive the mill.



An Allis-Chalmers 4000 kw, 3 machine synchronous M-G set (shown preceding photo) converts the power to drive the four stand continuous billet mill. Speed of the four 1250 hp motors is regulated by *Regulex* variable voltage control.

G M G

SEE THE EXHIBIT AT THE AISE CONVENTION

CUTAWAY & WORKING MODELS

- Tube-Cooled and General Purpose Motors
- Liquid Rheostat
- Air Break Contactor
- CW Solids Pump
- D-C Positioning Device

BOOTHS 35, 36, 37
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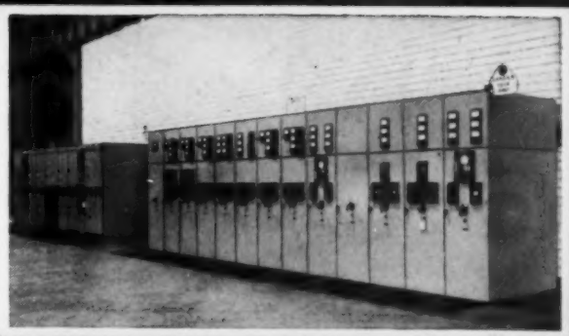
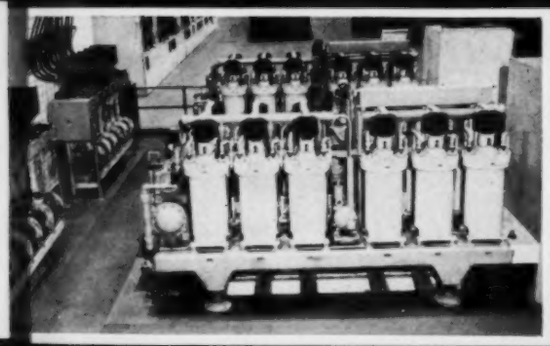
CLEVELAND PUBLIC AUDITORIUM

General purpose a-c power is supplied through four Allis-Chalmers transformers totalling 10,000 kva (shown schematically). These are connected to 2300 volt metal clad (right front) and 480 volt metal enclosed (left) switchgear.





Direct current at 250 volts is distributed to mill supply through this Allis-Chalmers switchgear. Feeder breakers protecting d-c system and cathode breakers located here. Purchased and byproduct power systems meet in d-c mill supply bus.

Power in Lorain Mill

sets (also A-C but not shown) enables each of the continuous billet mills to operate close-coupled.

The National Tube company has bought a wide range of associated apparatus from Allis-Chalmers and has gained undivided responsibility for the operation of this equipment. National Tube already knew from experience that A-C equipment is reliable; 12 Allis-Chalmers motors in No. 1, 2 and 3 Seamless mills, ranging from 600 to 3500 hp, are now approaching a quarter century of service.

A qualified steel mill representative will give personal attention to the electrical requirements of *your* plant modernization or expansion. A-C builds a complete range of generation, switching, conversion, rectification, drive, and control equipment. Offices in all major cities.

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A-C CHALMERS

Processing Equipment for Iron and Steel

A-C ALLIS-CHALMERS

A-3131

for

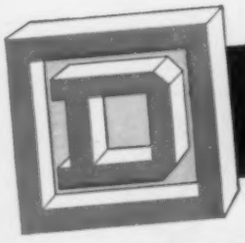
NATIONAL TUBE COMPANY

Square D controls operate the double spindle coupling screw-on machines for the No. 4 seamless tube mill at the National Tube Company, Lorain Works. These panels illustrate typical tailor-made construction for the specific machines. They incorporate D.C. mill auxiliary control for D.C. motors as well as A.C. control for a hydraulic system involving many electrically operated valves.

Electrical controls for mill machinery become more complex with the demand for more automatic operation and faster production. This trend emphasizes the need for careful circuit design and complete lines of dependable, trouble-free component devices such as Square D has available.

A nation-wide field engineering organization facilitates and coordinates design planning between the user, the machinery builder and the Square D factory. Trained engineers, located in principal cities, are at your service.

Controller above operates double spindle coupling screw-on machines at National Tube Company, Lorain Works.



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What features do you require in your soaking pit linings—savings in fuel costs? . . greater mechanical strength and rigidity? . . low first cost and shorter installation time? . . corrosion resistance? . . much longer life? . . freedom from repairs? . . these features and many more can be enjoyed by you after you install Buckeye Silica Firestone.

*Performance records prove that Buckeye is best. Heads of masonry departments appreciate and recommend this modern refractory's money-saving installation possibilities . . . operators know how much longer service can be expected from a Buckeye-lined pit!

Steel mill executives, who have used Buckeye Silica Firestone for years, will give you many reasons for your specifying this up to date, better lining material for your soaking pits. Our service engineers will gladly work with you to obtain the finest possible results from your Buckeye installation. Ask for this service.

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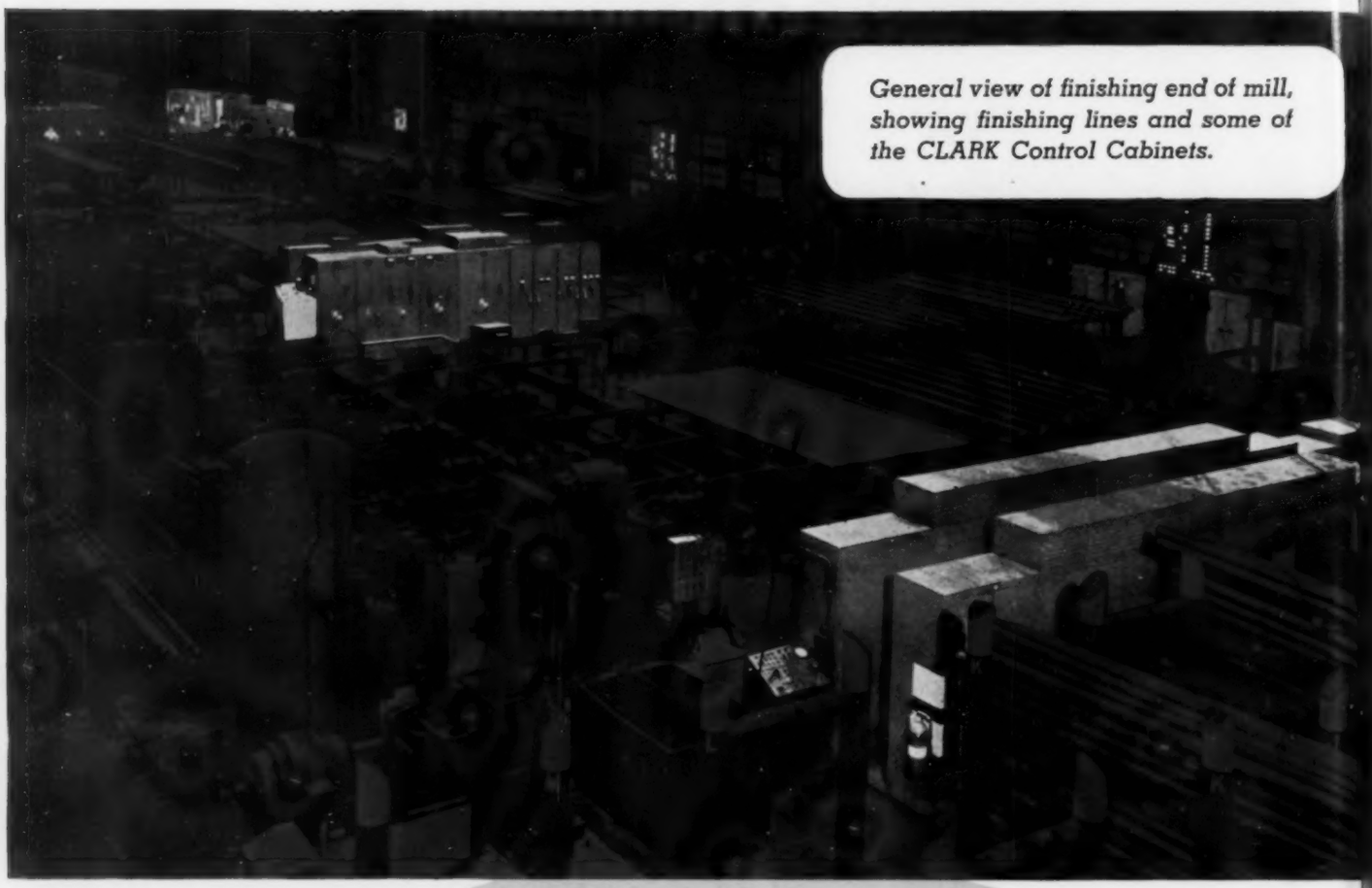
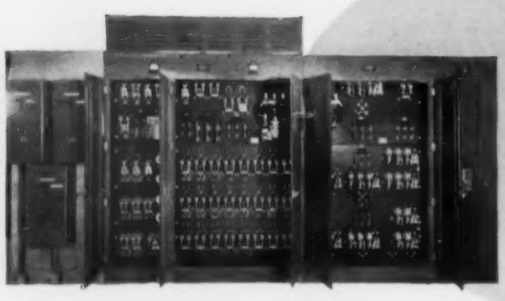
BUCKEYE
"FOR THAT EXTRA SERVICE"
SILICA FIRESTONE

CLARK CONTROL AIDS P

in world's "first of its kind"—A

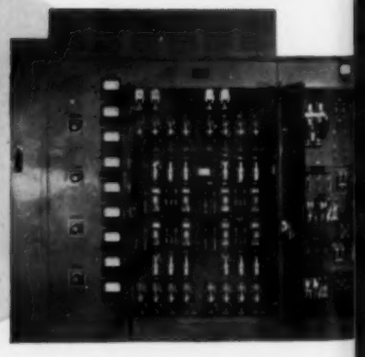


General view of finishing end of mill, showing finishing lines and some of the CLARK Control Cabinets.



Typical section of Hydro Press Test Control Panels.

Typical section of Stamets Cut-Off Machine Line Tandem Control.



Typical section of Stamets Chamfer Drive Control.

On these two pages are pictured just a "token showing" of the many CLARK Control panels which function to help make automatic continuous production possible in the new mill.

CLARK Heavy-duty Mill Control apparatus provides dependable performance, long life, and minimum maintenance for all types of rugged mill operations.

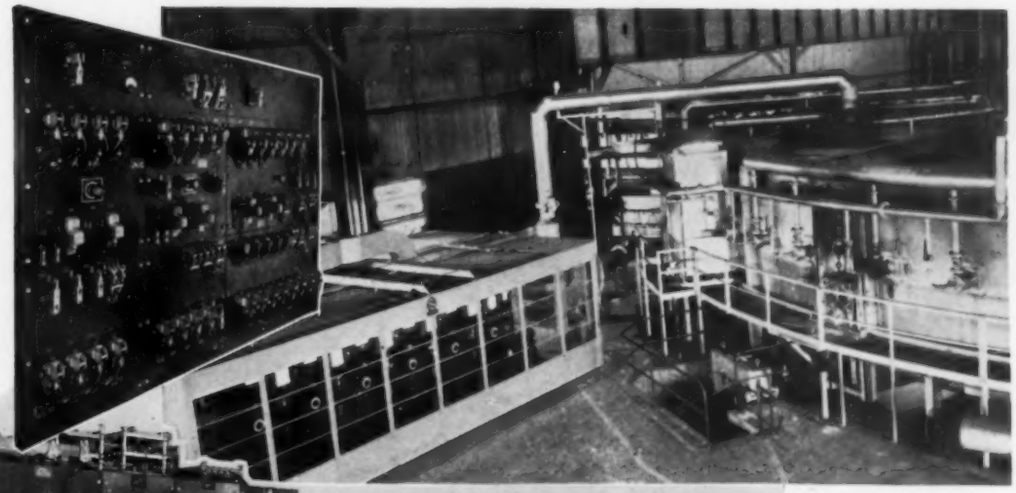
CLARK ENGINEERED ELECTRICAL CONTROL

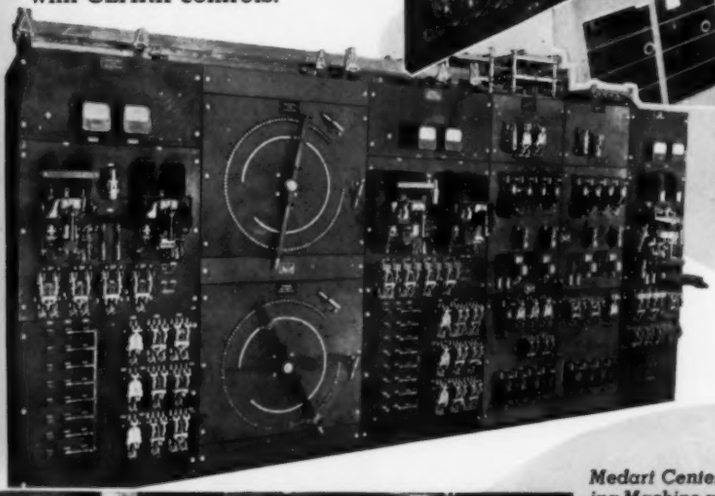
PRODUCTION

—AUTOMATIC SEAMLESS TUBE MILL

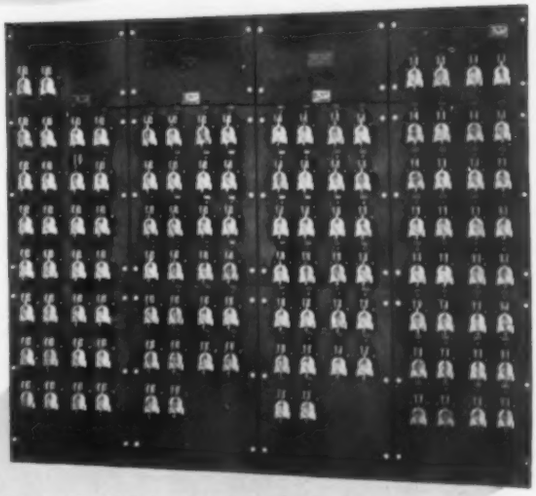
The No. 4 Continuous Automatic Seamless Tube Mill of National Tube Company, Lorain, Ohio, is the "first of its kind in the world."

Innumerable electrical control problems were presented in making operations automatic. CLARK engineers, cooperating with NATIONAL TUBE COMPANY engineers, solved many of these problems with CLARK controls.

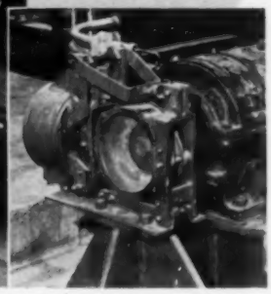




Control House and general area around Rotary furnaces. Above left—Section of Control for Salem Engineering Co. Rotary Furnace. Left—Control for Reheating Furnace, Discharge Conveyor, Reducing Mill Outlet Conveyor, Sizer to Cooling Table Conveyor.



Typical Field Relay Panel for Conveyors.



Medart Centerless Turning Machine and Medart 2 role straightener. Below—CLARK Bulletin 106 Brake on drive motor, Sizer to Cooling Table Kickout.

Clark Engineering know-how is available in every steel-producing center to solve your electrical control problems.

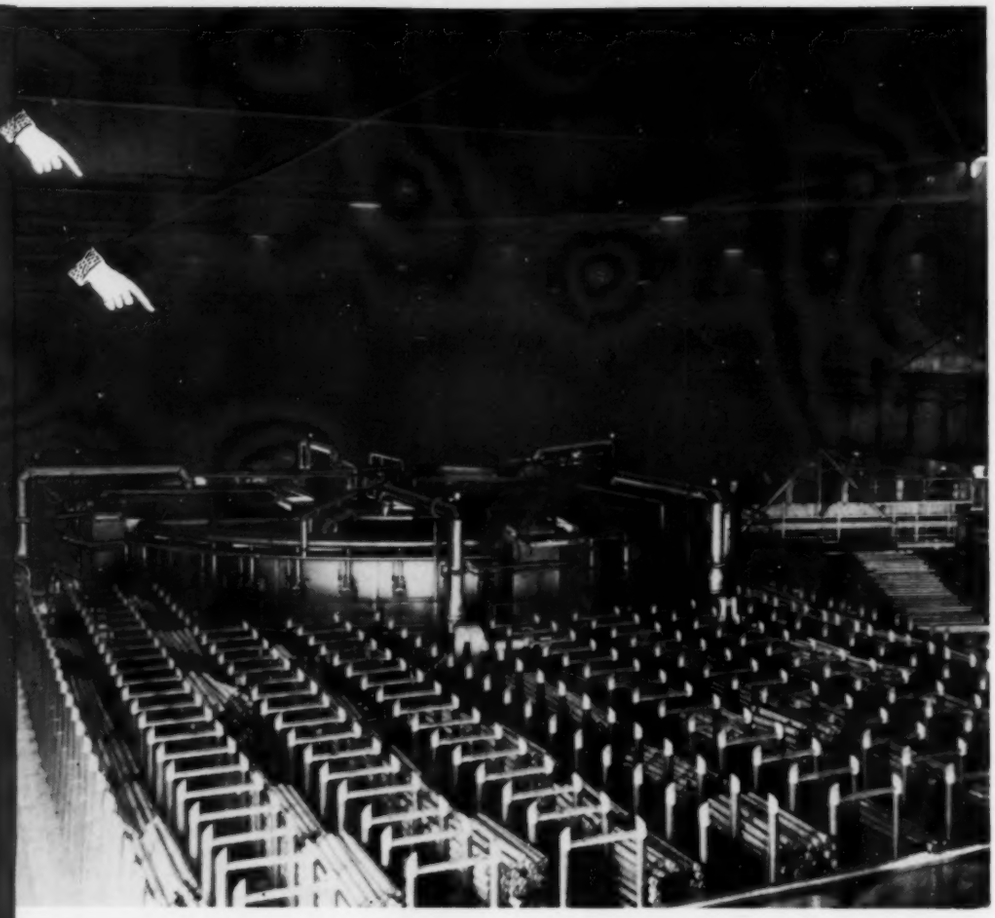
THE CLARK CONTROLLER CO.

1146 EAST 152ND STREET · CLEVELAND 10, OHIO

on the world's largest rotary hearth furnace

AT LORAIN NATIONAL TUBE CO. PLANT

you'll find this mark



This furnace, designed and built by Salem, is the world's largest steel heating Rotary Hearth Furnace. It has an outside diameter of 86 feet, height of 14 feet, and an inside chamber width of 19 feet. The furnace will heat 75 to 80 tons of cold steel per hour.

The automatic charging and discharging machines are designed to handle billets in a wide range of diameters and lengths.

The furnace is equipped with complete temperature, pressure and fuel/air ratio controls, flat suspended roof, variable hearth speed, and all modern improvements.

Of course we have incorporated the patented Salem double-hearth construction to prevent hearth distortion and assure trouble-free operation.

Large or small, whatever your furnace requirements may be, you'll find it advantageous to consult Salem.

SALEM BUILDS

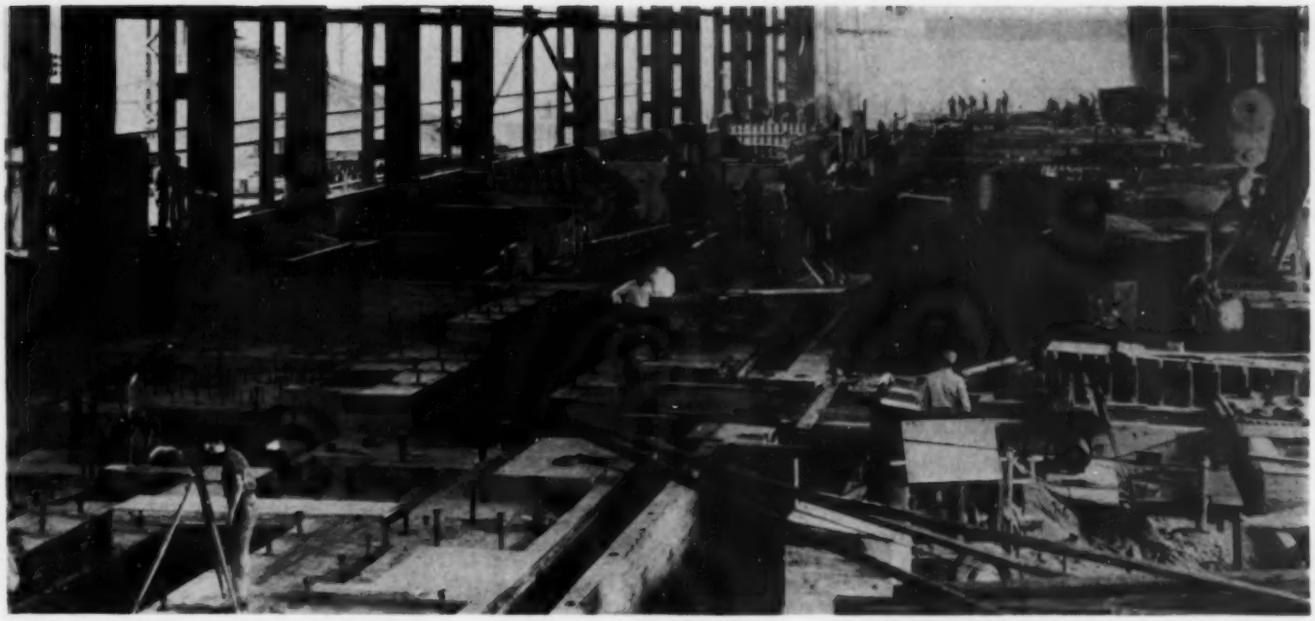
Salem circular soaking pits, rotary hearth furnaces, car bottom furnaces, forge furnaces, heat treating furnaces, gas atmosphere furnaces, air recirculating furnaces, needle metallic recuperators, continuous butt-weld furnaces and mechanical equipment for charging and discharging furnaces.

Salem Engineering Company

HEADQUARTERS FOR HEAT TREATING DESIGN

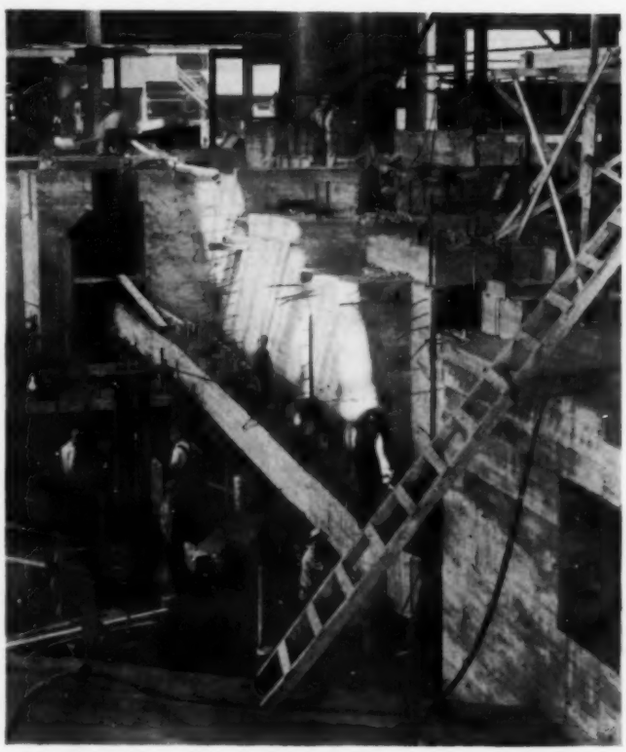
Salem, Ohio

SALEM ENGINEERING (CANADA) LTD., TORONTO, ONT.
SALEM ENGINEERING COMPANY, LTD., MILFORD nr. DERBY, ENGLAND



Look Beneath the Surface

of



THE BLOOMING, BAR AND BILLET MILL

THE CONTINUOUS SEAMLESS MILL

THE BUTT WELD MILLS

THE SOAKING PITS

THE COKE OVENS

THE WAREHOUSE

At

NATIONAL TUBE COMPANY'S

LORAIN WORKS

There is Something Concrete

by

THE HOLMES CONSTRUCTION CO. INC.

WOOSTER, OHIO

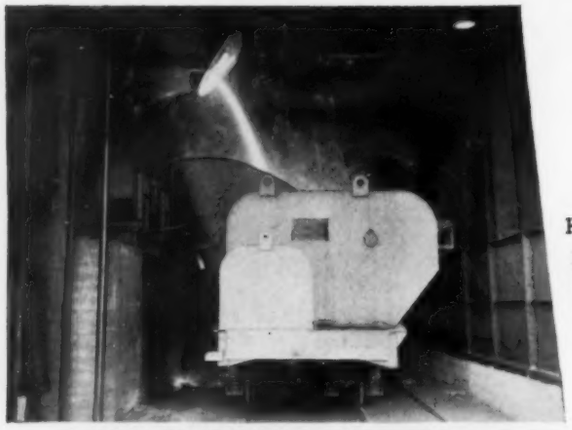
EC&M Control is Safe for Hot Metal Applications

Bessemer Converters operate *safely* under EC&M Control. This three-converter installation is typical of many EC&M controlled converters.

Wherever hot metal is stored, handled, or processed, many firms, acquainted with EC&M value, select this quality apparatus because of their confidence in it—in the engineering and experience which it represents.

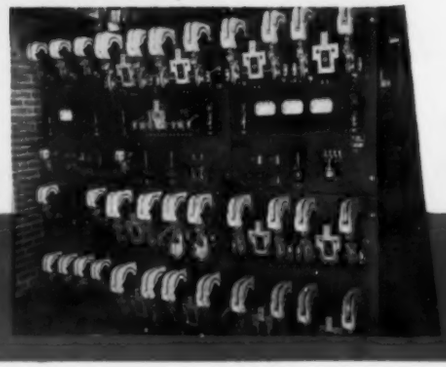
Typical hot metal applications include (1) Ladle Cranes, (2) Hot Metal Cranes, (3) Hot Metal Mixers, (4) Bessemer Converters, (5) Storage Vessels, (6) Ladle Cars—where only tried and true equipment, which represents the utmost in safety and dependability, is acceptable.

Listed below are a few of the EC&M products especially designed for the requirements of hot metal service. They have proved themselves highly successful in many applications throughout the years. Specify EC&M Control for hot metal applications.



Hot metal mixer pouring into hot metal car, both of which are operated by EC&M Control.

EC&M power-circuit type Limit Stops mounted on hot metal mixer (shown above), provide positive slowdown and final stopping.

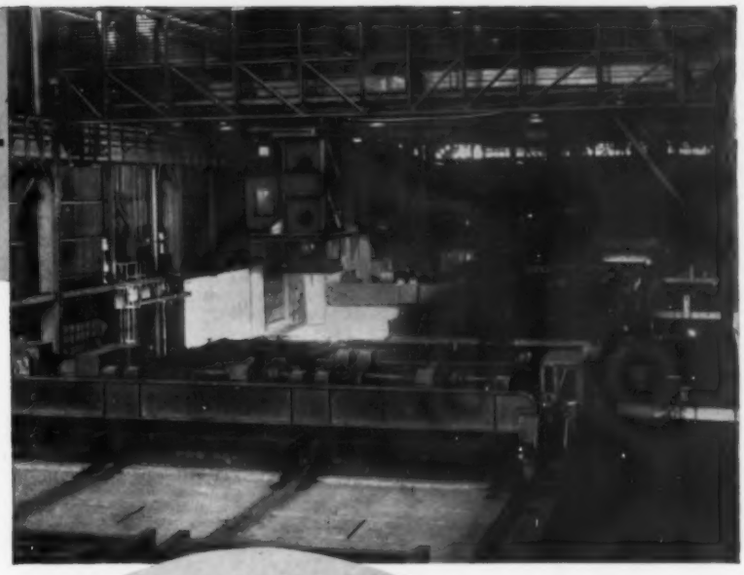


LINE-ARC Contactor Control for the hot metal car propel-motion.

EC&M EQUIPMENT
Especially Designed for Hot Metal Service

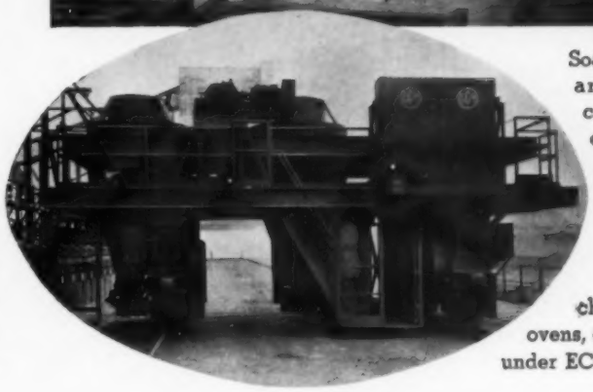
1. Basic Control Systems for Bessemers & Mixers, many originated by EC&M.
2. Dead - Man's Master Switch.
3. Air and Magnetically-released Brakes.
4. Positive-type Limit Stops for Slowdown and Final Stopping.
5. LINE-ARC Magnetic Contactor Controllers.

Advantages of
EC&M TIME-CURRENT CONTROL
for cranes, larry cars, etc.



1. *Load-controlled acceleration by TIME-CURRENT Relays.* If the motor current is low, relay time will be negligible, allowing the acceleration-contactor to close quickly. Operators *appreciate this load-responsive characteristic* and *use it to advantage* when taking the swing out of the hook, spotting a load, etc.

2. *Improved LINE-ARC Contactors cut upkeep costs.* Current carrying parts and LINE-ARC principle remain unchanged, but a new magnetic circuit eliminates the magnetic-dust problem and new double-break, isolated interlocks provide safer electrical interlocking. Contact-renewal, when needed, is simple—front and rear contacts can be changed in less than two minutes—contacts are loosened or tightened with a standard wrench and without dismantling any other contactor parts.



Soaking-pit cranes and pit-cover cranes, both operated by EC&M Control.

Larry Car for charging coal into ovens, operates smoothly under EC&M Control.

SPECIFY EC&M
(TIME-CURRENT LINE-ARC CONTACTOR) CONTROL

Blooms are handled by 15-ton Turntable-trolley Cranes, EC&M equipped.

200-Ton Ingot-Stripper Crane, EC&M Controlled.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

THE DINGLE-CLARK CO.

ELECTRICAL CONTRACTORS

PITTSBURGH — CLEVELAND (MAIN OFFICE) — PHILADELPHIA

32 YEARS OF STEEL MILL ELECTRICAL CONSTRUCTION EXPERIENCE PRODUCES SUCCESSFUL ELECTRICAL CONSTRUCTION PROJECTS

- SOUND MANAGEMENT AND BUSINESS POLICY
- FINANCIAL STABILITY
- TECHNICAL RESPONSIBILITY
- PURCHASING AND EXPEDITING ABILITY
- EXPERIENCED FIELD CONSTRUCTION SUPERVISION

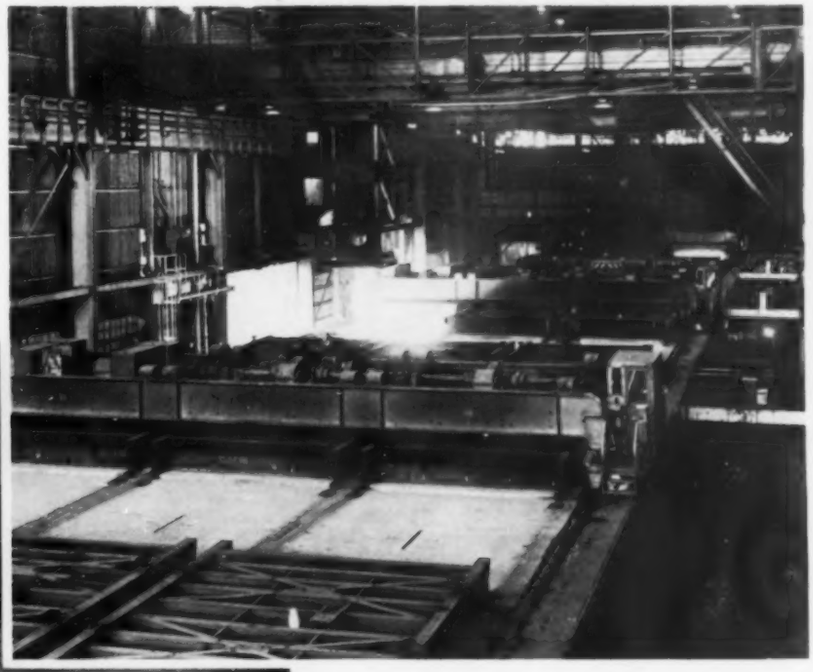
THE DINGLE-CLARK CO. INSTALLED THE ELECTRICAL CONSTRUCTION ON THE

BLOOMING MILL
BAR MILL
BILLET MILLS
SOAKING PITS
AT

THE NATIONAL TUBE CO.
LORAIN
OHIO

The "Best for Service" in Soaking Pit Covers

Photo to right shows an overall view of the 24 soaking pit shop at National Tube Company, Lorain, Ohio. This whole shop is equipped with our unitary type sand seal design of suspended pit cover. The pickup type cover crane spans three pits. Inside dimension of each pit is 15'-0" by 12'-6". Partition wall between pits is 3'-6" and clearance between covers is 1'6½".



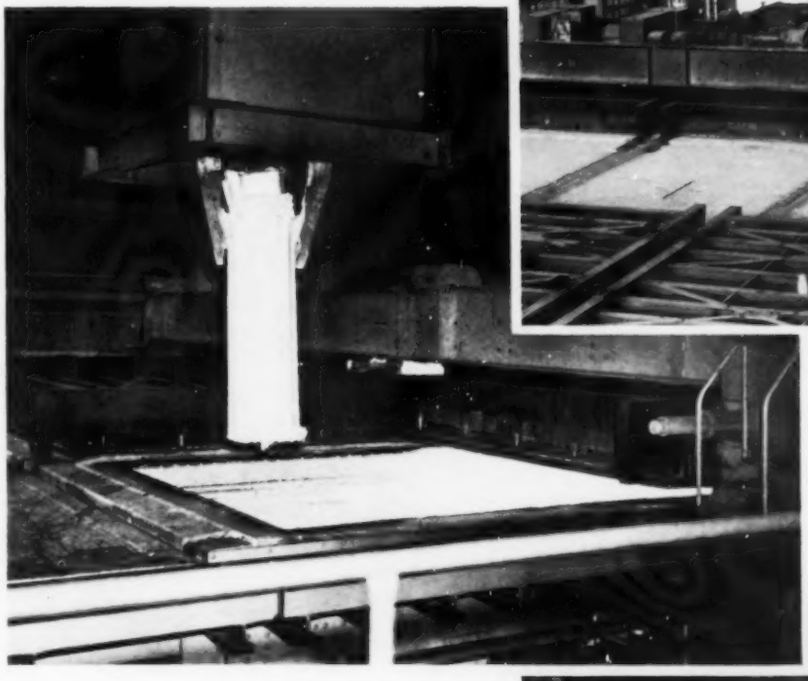


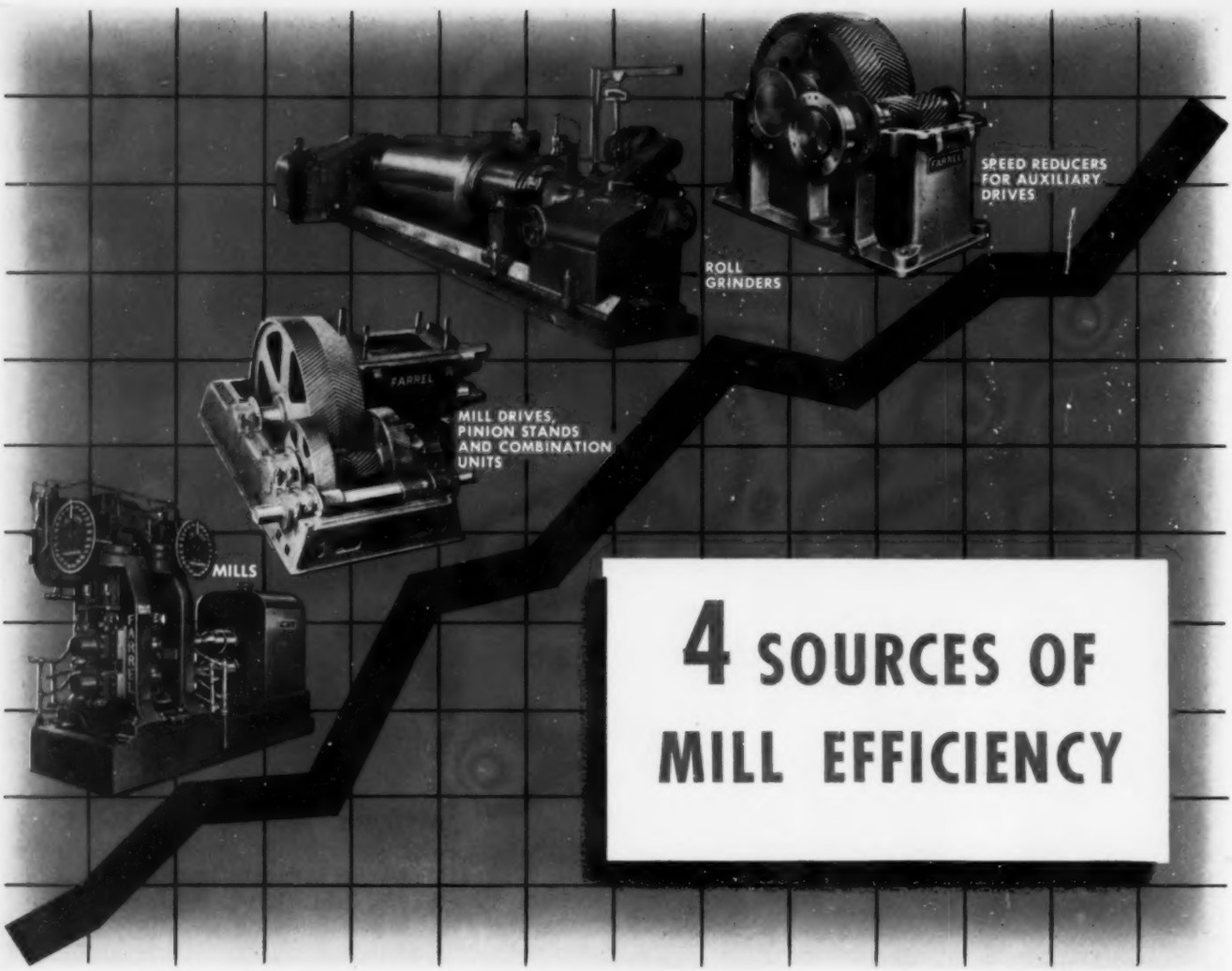
Photo to left shows one of these covers partly open as an ingot is removed. The adjacent cover, in close position, shows the corner support posts located outside the pit walls. This distance between posts and the sand seals is a valuable operating clearance.

Photo to right shows the same type of suspended pit cover which is located in another plant where the covers are operated by individual carriages. Note how the overlapping sand seal castings on this design of cover protects the steel frame against direct exposure to the white hot pit when the cover is moved to open position. These pits are 16'-0" by 7'-0". The partition wall between pits is 3'-0" and clearance between covers is 1'-0". In this steel plant we have a total of 58 covers in service.

Throughout the steel industry we have very close to 150 pit covers in service, all of which utilize the unitary type sand seals.

FRAZIER-SIMPLEX, INC.

436 EAST BEAU STREET **WASHINGTON, PENNA., U. S. A.**



4 SOURCES OF MILL EFFICIENCY

For close to a century Farrel engineers have specialized in rolling mill equipment, designed to improve the efficiency of metal production.

MILLS are built in a wide range of sizes for rolling nonferrous rods, strips or sheets, metal foils and cold strip steel. Farrel also designs and manufactures coilers and special handling equipment required to make each installation a complete production unit.

MILL DRIVES, PINION STANDS AND COMBINATION UNITS are specially designed to suit individual requirements. Single, double and multiple reduction gear units are available in a wide range of ratios and capacities. Pinion stands with single or double helical pinions are built in any size, for any capacity. Combination units include reduction gear drive and pinion stand in a compact, integral housing.

ROLL GRINDERS are available in two types and nine standard sizes. These machines grind rolls with a perfect surface, free from marks of any kind, either straight, or with concave or convex contours of exact symmetry and accuracy.

SPEED REDUCERS FOR AUXILIARY DRIVES – These units are available in a wide range of ratios and capacities. Designs include single, double and multiple reduction units; speed-change units; right-angle drives and drives to meet special requirements.

Information and engineering consultation available, without obligation.

FARREL® ROLLING MILL MACHINERY

Rolls • Rolling Mills • Rod Mill Tables and Manipulating Equipment Universal Mill Spindles • Rod Coilers • Gears • Mill Pinions • Pinion Stands • Gear Drives of any Capacity • Flexible Couplings • Roll Grinding Machines • Roll Calipers • Lead Presses for Pipe or Rod.

FB-573

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

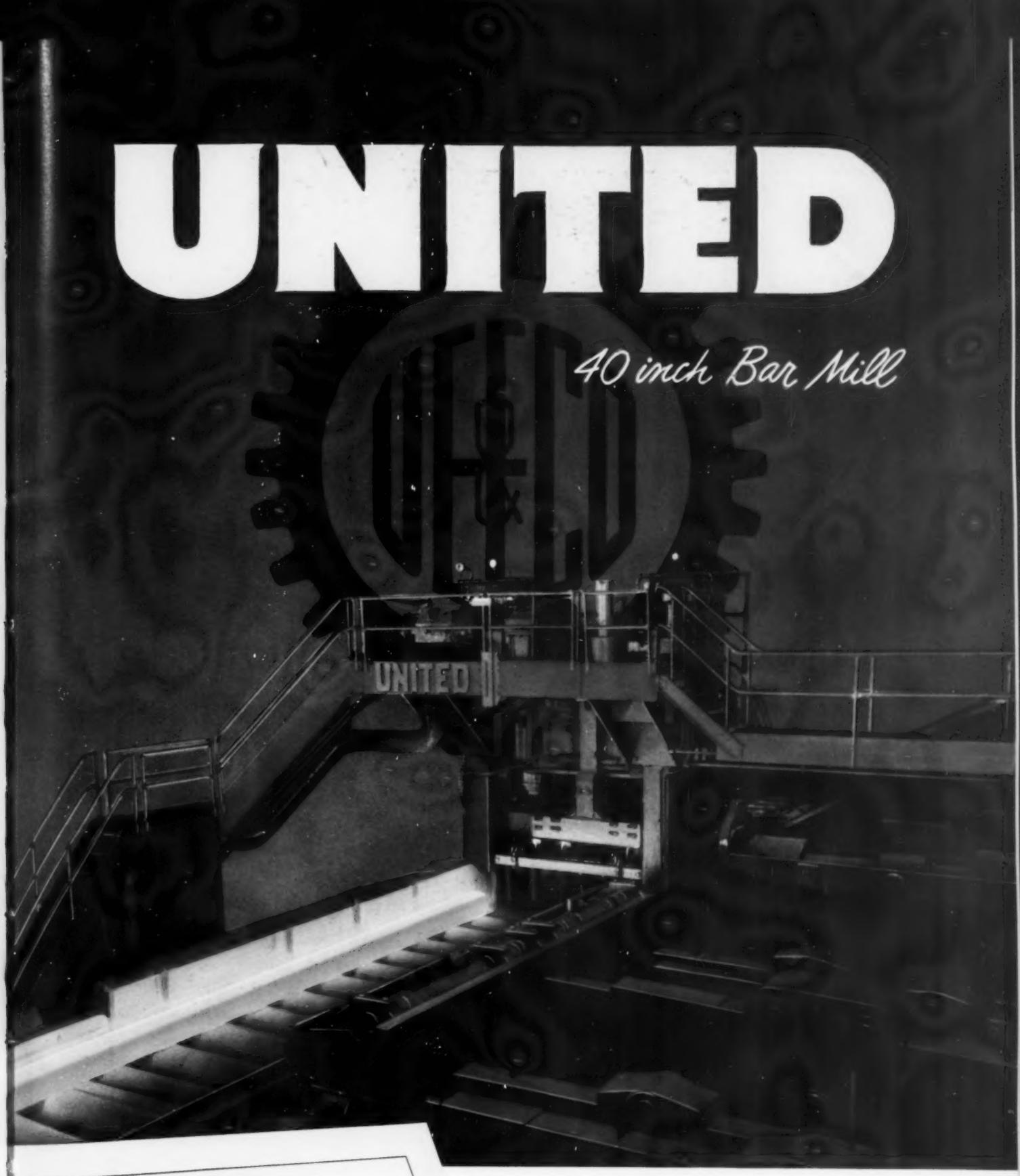
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.

Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Cleveland, Detroit, Chicago, Los Angeles, Tulsa, Houston

Farrel-Birmingham®

UNITED

40 inch Bar Mill



UNITED ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Plants at

PITTSBURGH, VANDERGRIFT, NEW CASTLE, YOUNGSTOWN, CANTON

Subsidiaries:

Adamson United Company, Akron, Ohio
Lobdell United Company, Wilmington, Delaware
Stedman Foundry and Machine Company, Inc., Aurora, Ind.

Designers and Makers of Rolls and Rolling Mill Equipment

THEY GAVE A GOOD MAN THE AIR . . .

Good Air!

Four 60", 3-HP IRON LUNG roof ventilators do the rugged job of ventilating No. 5 Skelp Mill at the National Tube Co., Lorain, Ohio.

To do his best, a good worker needs clean, fresh, comfortable air. And progressive concerns are wisely giving it to him. Good air is invigorating. It keeps the head clear, the body healthy, the spirits high.

That's the kind of air the IRON LUNG roof ventilator is bringing to thousands of busy workers in many of the nation's great steel mills — to management it is bringing greater proof of the economy and value of good ventilation as provided by the modern, electrically operated IRON LUNG.

In performance the IRON LUNG is superbly efficient. Because of its high velocity the air stream carries the polluted air so high above the roof that fumes and other impurities cannot return to buildings through open doors and windows.

Before another 3-shift winter sets in, your ventilating needs should be measured and the cost of dependable equipment estimated. Our experienced engineers will do this for you without charge or obligation. Write for Catalog and Data Sheet.

IRON LUNG VENTILATOR COMPANY • 4014 Prospect Avenue, Cleveland 3, Ohio

IRON LUNG
FOR INDUSTRIAL BUILDINGS

These **dependable** Bailey PRODUCTS

are serving NATIONAL TUBE COMPANY

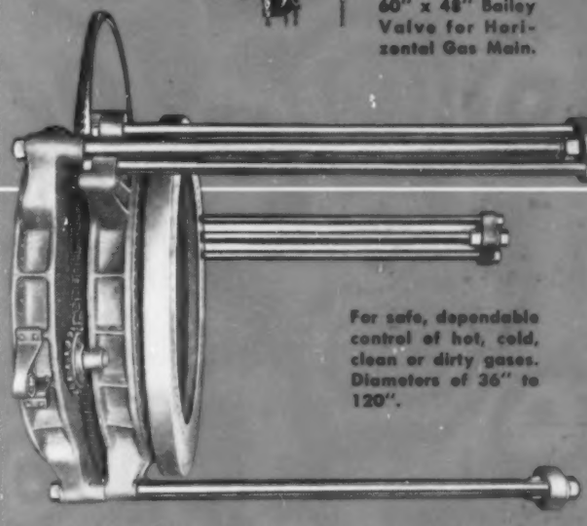
MECHANICAL VALVES

Noted for their dependable operation under all conditions, Bailey Mechanical Goggle Valves provide a tight, positive seal for shutting off gas mains in emergencies or for repairs. Requiring a minimum of maintenance, they operate by a powerful clamping force which is applied equally at all points around the disc periphery. Regardless of time between operations, they open or close instantly. Sizes from 6" to 72", totally enclosed if desired.

60" x 48" Bailey Valve for Horizontal Gas Main.

THERMAL VALVES

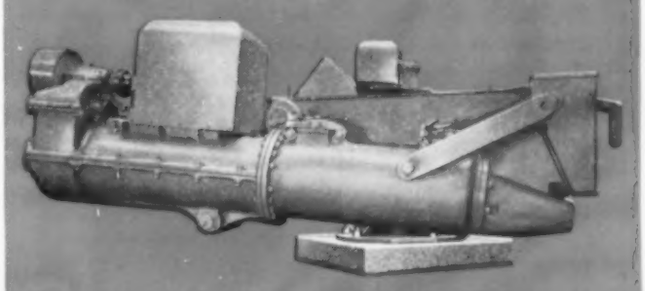
Operated by the lineal expansion and contraction of three sets of tubes spaced around a rigid steel flange, the Bailey Thermal Valve is always safe, dependable and *ready*. When steam is passed through the tubes, thermal expansion creates a powerful force that instantly frees the goggle plate and permits valve operation. When the steam is removed, contraction closes the flanges against the plate, forming a tight seal. Can be operated by hand in case of steam failure.



For safe, dependable control of hot, cold, clean or dirty gases. Diameters of 36" to 120".

CLAY GUN

Powerful electric drive provides the piston pressure necessary to maintain long and uniform tapping holes. Special Bailey Lever Action forces the nose of the gun into position with positive accuracy. Piston is driven by an electric motor through reducing gears. The Bailey Clay Gun is dependable and safe.



This gun will stop the tapping hole with full wind on the furnace. Clay pressure 600 lb./sq. in.

WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD · PITTSBURGH 16, PA.

There are only 1500 square feet of floor space in these two self-contained canteens.

PRODUCTION FOOD FOR ~~THOUGHT~~

THERE'S NO TIME LOST . . . WAITING FOR SERVICE AT NATIONAL TUBE COMPANY'S LORAIN PIPE MILLS

Stop in for coffee **with us at the Iron and Steel Exposition (Booth 336-339) and find out how we have put food service on a business basis at:**

Allegheny-Ludlum Steel Corp.
Allis-Chalmers Manufacturing Company (Gadsden)
American Steel & Wire Co.
Anheuser-Busch, Inc.
Astatic Corporation
Carnegie-Illinois Steel Corp.
Continental Can Company (Pittsburgh)
Continental Rubber Works
Erie Meter Systems, Inc.
Erie Resistor Corporation
Jones & Laughlin Steel Corporation (Cleveland)
Midland Steel Products Co.
National Tube Company
Ohio Rubber Company
Detroit Steel Corporation (Portsmouth)
Precision Castings Co., Inc.
Republic Rubber Division of Lee Tire & Rubber Company
Republic Steel Corporation
Sharon Steel Corporation
Standard Steel Spring Co. (Gary)
Tinnerman Products, Inc.
Truscon Steel Company

These two new carry-out canteens at Lorain serve a variety of nourishing hot and chilled foods to an average of more than 5,000 customers a day.

Engineered just like any other production facility, these compact canteens were designed and erected by Factory Stores' specialists, who operate them around-the-clock on a self-sustaining basis.

Everything is prepared and pre-packaged right on the spot, just ahead of minute-to-minute demand.

Factory Stores

BOOTH 336-339

Serving the iron and steel industry since 1919

PENNSYLVANIA ENGINEERING CORP.

NEW CASTLE, PENNA.

BUILDS

BESSEMER CONVERTERS, HOT METAL MIXERS

AND

AUXILIARY EQUIPMENT

FOR

NATIONAL TUBE CO'S NEW BESSEMER PLANT AT LORAIN, OHIO

CONVERTERS BLOWING AT LORAIN, OHIO

The equipment furnished by Pennsylvania Engineering Corporation at Lorain was all welded and of new design and consisted of four 25-ton Bessemer Converters, two 800-ton Hot Metal Mixers, Jack Cars, Bottom Oven Cars, Scrapping Car, Transfer Cars from Mixer to Converters, Hot Metal Transfer Cars from Converters to Ingot Pouring Platform.

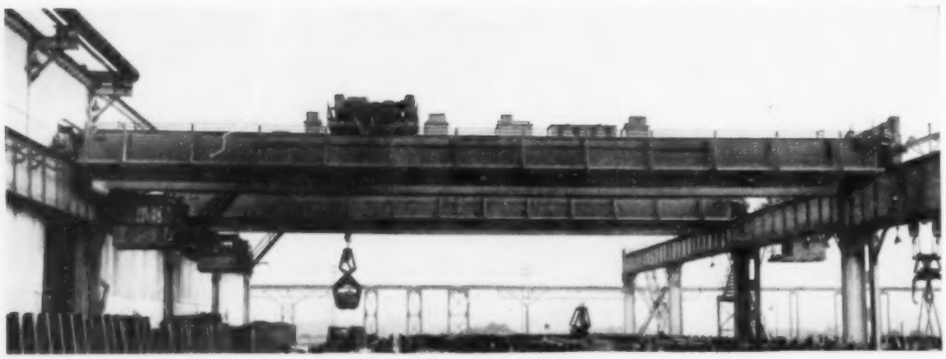
DESIGNERS, FABRICATORS AND ERECTORS OF STEEL MILL EQUIPMENT

TOOL STEEL PROCESS

CRANE GEARING

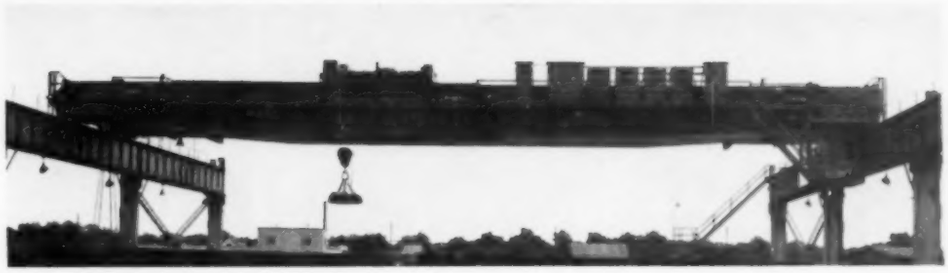
"TOOL STEEL" PROCESS

guaranteed gearing carries the load



TOOL STEEL PROCESS

CRANE GEARING



at the Lorain Plant of National Tube Company

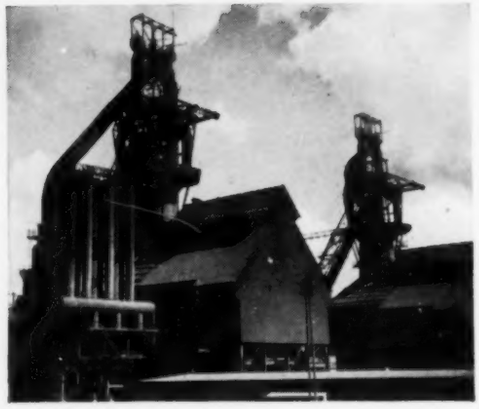
VISIT OUR BOOTH
240, 241 AT THE
EXPOSITION.

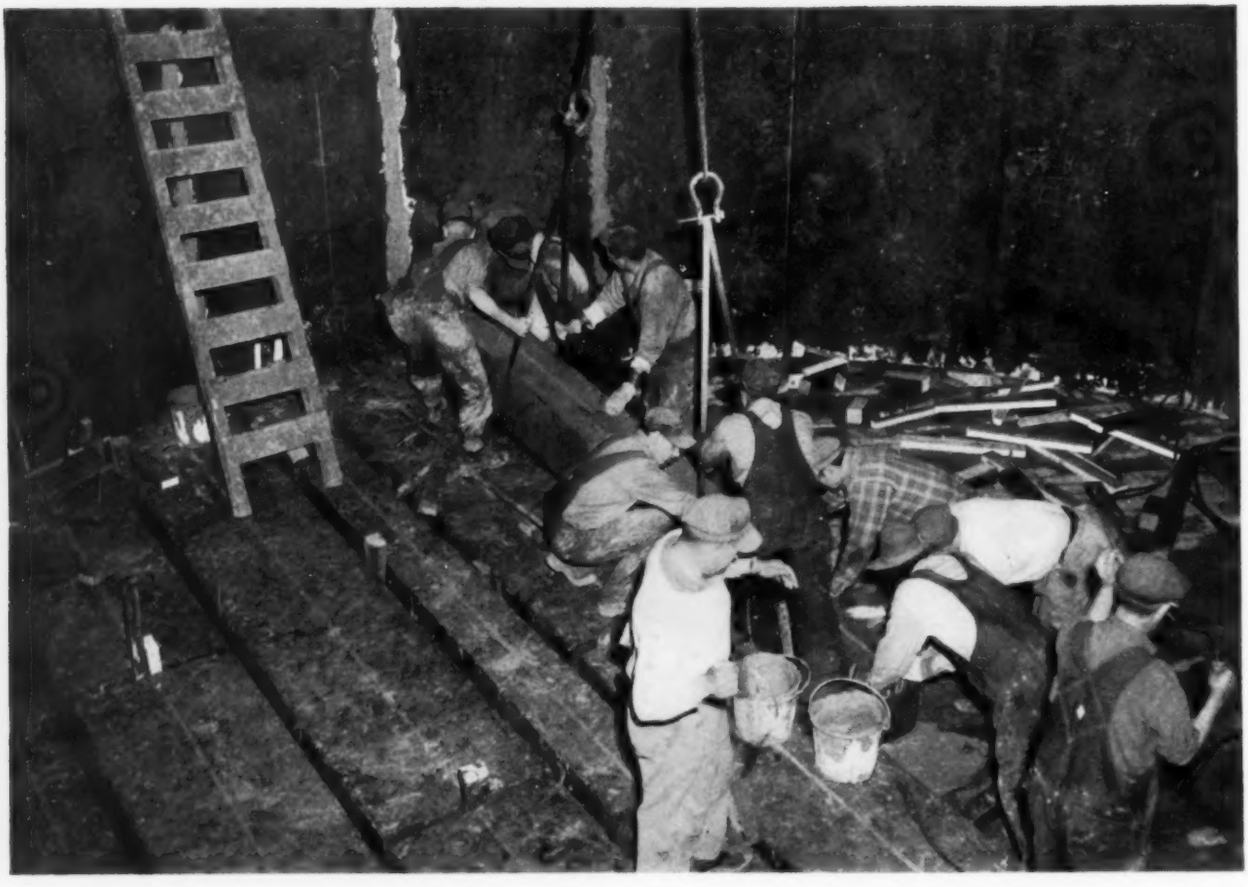
TOOL STEEL PROCESS

CRANE GEARING

1,841,000 TONS WITH ONE "NATIONAL" CARBON LINING!

...and still going strong!





● Carbon is the ideal material for lining blast furnaces. One example proving this statement is the record of one of the largest blast furnaces in this country, in which a "National" carbon block lining was installed several years ago. This furnace has produced approximately 1,841,000 tons of iron as of September 1, 1950 and is still going strong with the original lining.

The terms "National" and "Eveready" are registered trade-marks of

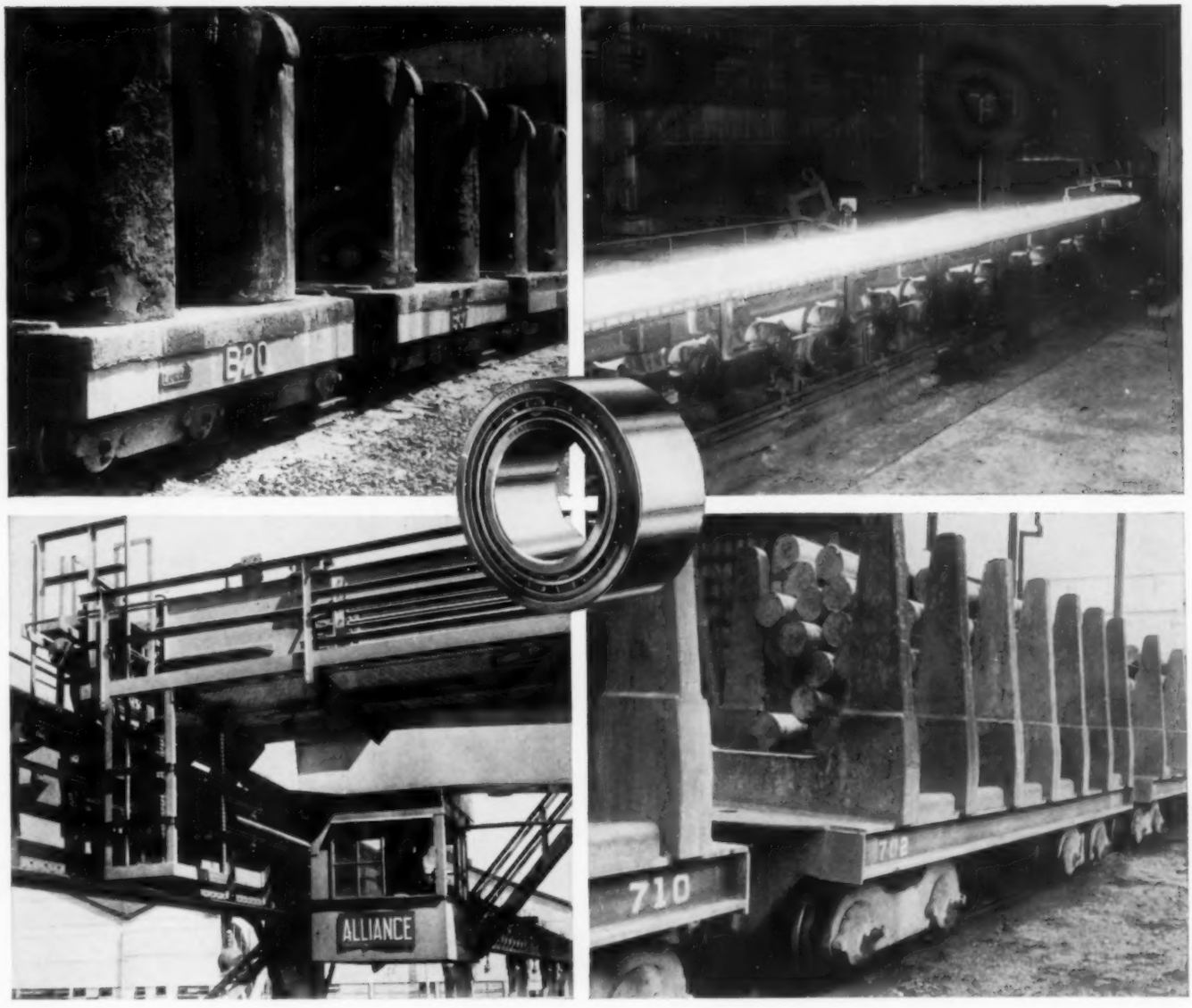
NATIONAL CARBON DIVISION
UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street, New York 17, N. Y.
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
Foreign Department: U. S. A.

MORE THAN DOUBLE THE USABLE LIGHT!

The biggest news since the invention of flashlights—the brand new, leak-proof "Eveready" No. 1050 flashlight battery—gives more than double the usable brilliant white light for critical uses than any other flashlight battery we have ever made.

●

NO METAL CAN TO LEAK OR CORRODE



Easing the loads at Lorain

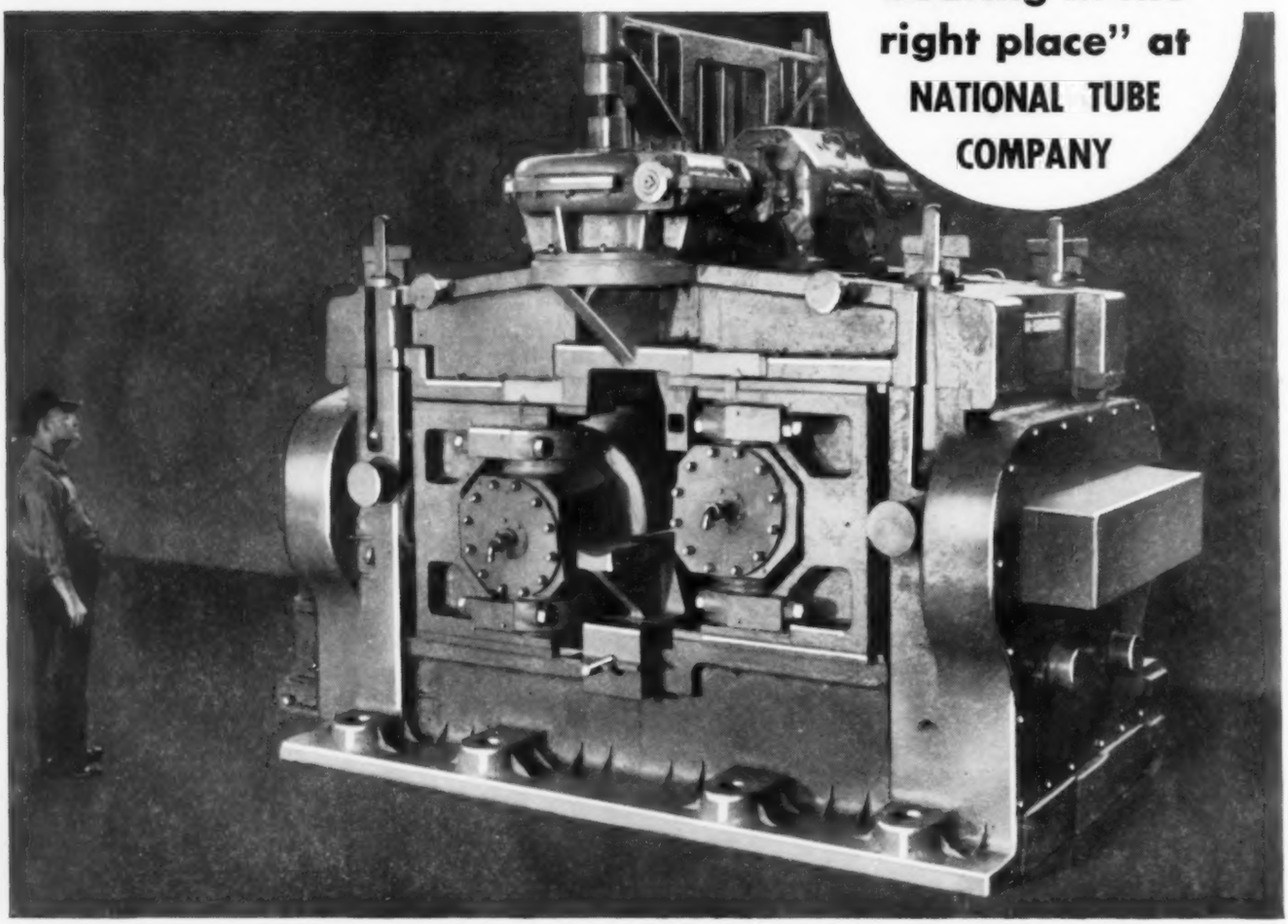
One of the reasons why the Lorain Works of National Tube is such a smooth running steel mill is its wise and generous use of Hyatt Roller Bearings.

The table rollers are Hyatt-equipped and the ingot, charging and transfer cars too. Likewise do the cranes and mill motors operate more smoothly with similarly dependable Hyatts.

Like most other steel mills, Lorain has proved by experience that Hyatts take the heavy loads with less bearing wear and care. Whether it is in the design of new equipment or in change-overs, Hyatts are the bearings preferred by most steel mills. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Chicago, Detroit, Pittsburgh and Oakland, Calif.

HYATT ROLLER BEARINGS

SKF
"Puts the right bearing in the right place" at NATIONAL TUBE COMPANY



Heavy traffic--
70 TONS worth for each SKF-equipped car

Seventy tons of ingots bear down on the eight wheels of National Tube's large size ingot cars. To handle the stresses set up by such a load the Carnegie-Illinois Steel Corporation, car builders, turned to SKF. Each wheel of the 111 ingot cars was equipped with SKF Spherical Roller Bearings—a total of 880 bearings. Warpage or deflection under heavy loads will not reduce their capacity to absorb highest radial and thrust pressures. Friction due to internal binding is not increased. No adjustment for running clearance is necessary. Ingots move smoothly, quickly, with minimum car down time.

It's another example of the *right* SKF Bearing for the job.

REELING tubing's no job for softies
...SKF takes it in stride

Reeling machines, built for the National Tube Company by Aetna-Standard Engineering Company, are heavy-duty machines in every sense of the word. They act as the driving and twisting force for the feeding of tubing—subject bearings to unusually heavy loads. Two SKF Spherical Roller Bearings per neck are used, a total of eight on each machine. These bearings permit major space economies without compromising shaft strength and bearing capacity.

SKF Bearings Smooth The Way For Peak Tonnages Rolling Through America's Steel Mills.

Table rolls, gear drives, reels, coilers, hot and cold saws—these and every other type of steel mill equipment must give exceptional service today. Bearings are increasingly important.

Strict control of manufacture, rigid inspection, and advanced engineering techniques are your assurance of SKF Bearings' ability to take tough vibration and shock treatment. SKF Bearing installations function efficiently, economically, with complete dependability.

SKF INDUSTRIES, INC., PHILADELPHIA, PA. *—the Pioneers of the Deep Groove Ball Bearing, Spherical Roller Bearing, Self-Aligning Ball Bearing.* 7122

SKF

BALL AND ROLLER BEARINGS

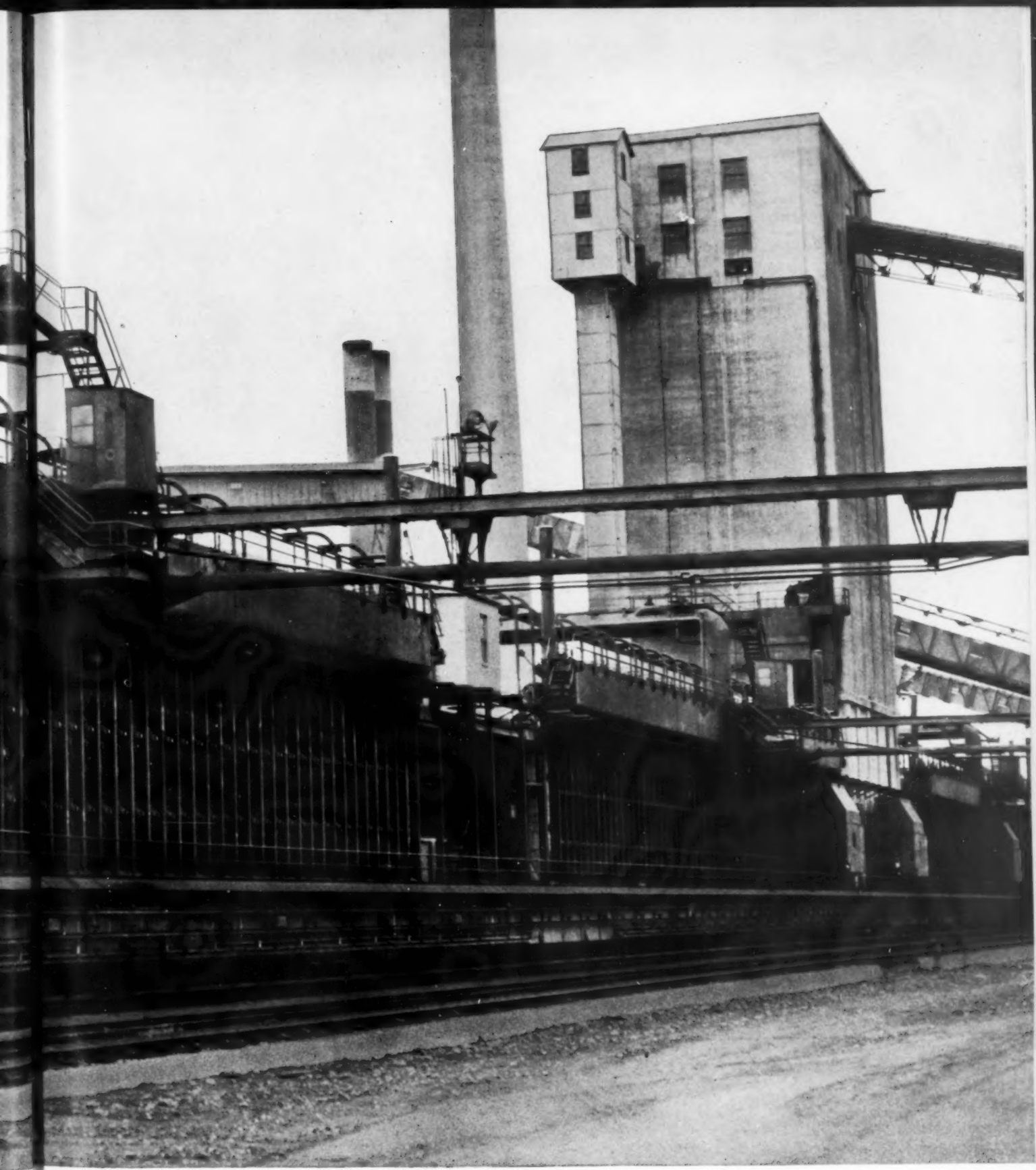
8 REASONS WHY SKF IS PREFERRED BY ALL INDUSTRY

Integrity — Craftsmanship — Metallurgy — Tolerance Control

Surface Finish — Product Uniformity — Engineering Service — Field Service

3 *batteries of*
WILPUTTE
underjet ovens

WILPUTTE

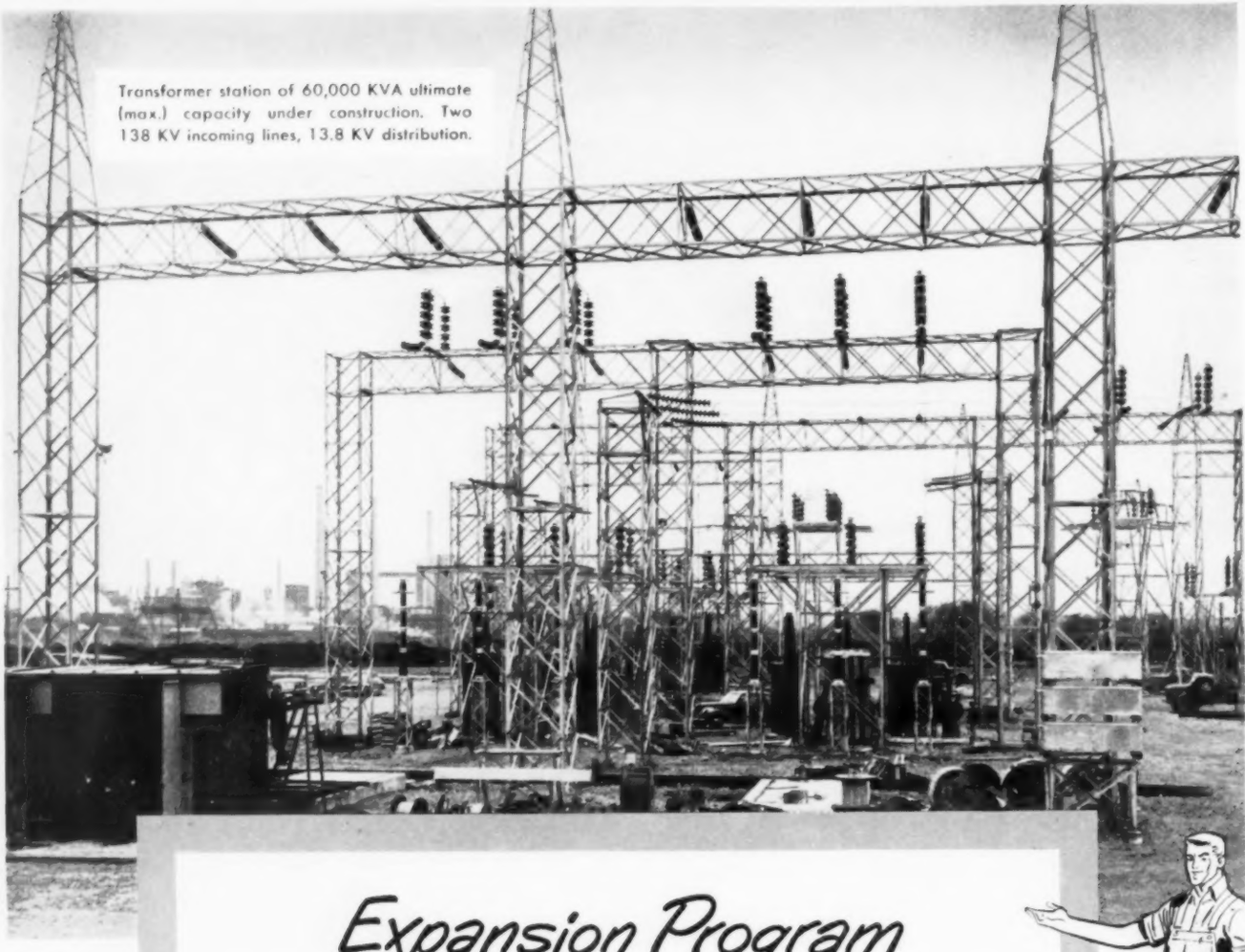


177 Wilputte Underjet Ovens installed for National Tube Company Lorain Works at Lorain, Ohio in 1947.

COKE OVEN DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 RECTOR STREET • NEW YORK 6, NEW YORK



Transformer station of 60,000 KVA ultimate (max.) capacity under construction. Two 138 KV incoming lines, 13.8 KV distribution.

Expansion Program

National Tube Company

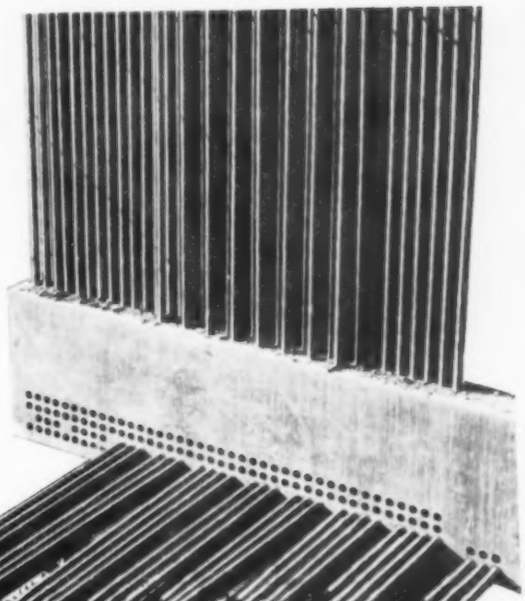
Lorain, Ohio, Works

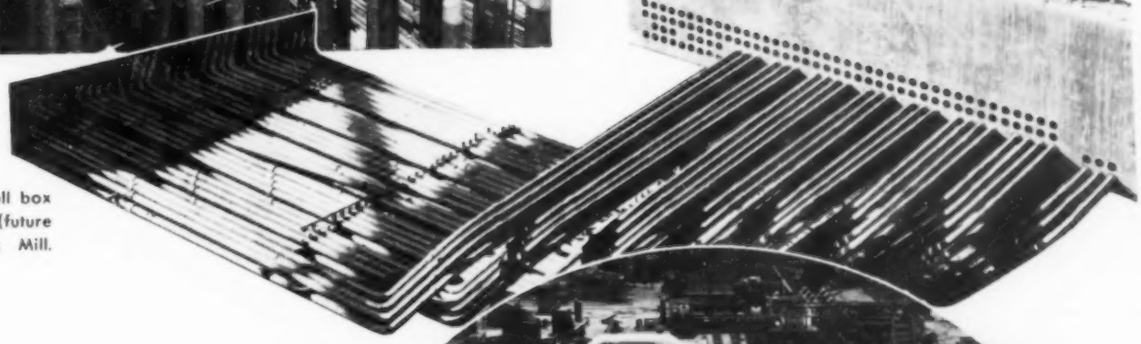
Quality in electrical construction work pays dividends the same as it does in the equipment to which it applies. It is reflected in an installation which not only functions as intended by the designers but likewise proves reliable and dependable in service for the owner.

The installations for National Tube Co. shown here are typical examples of electrical work executed by PEC for industrial plants of any type and for power stations. This same high quality engineering and construction service is available for small or large projects wherever located. For quality construction service send your inquiries to PEC.

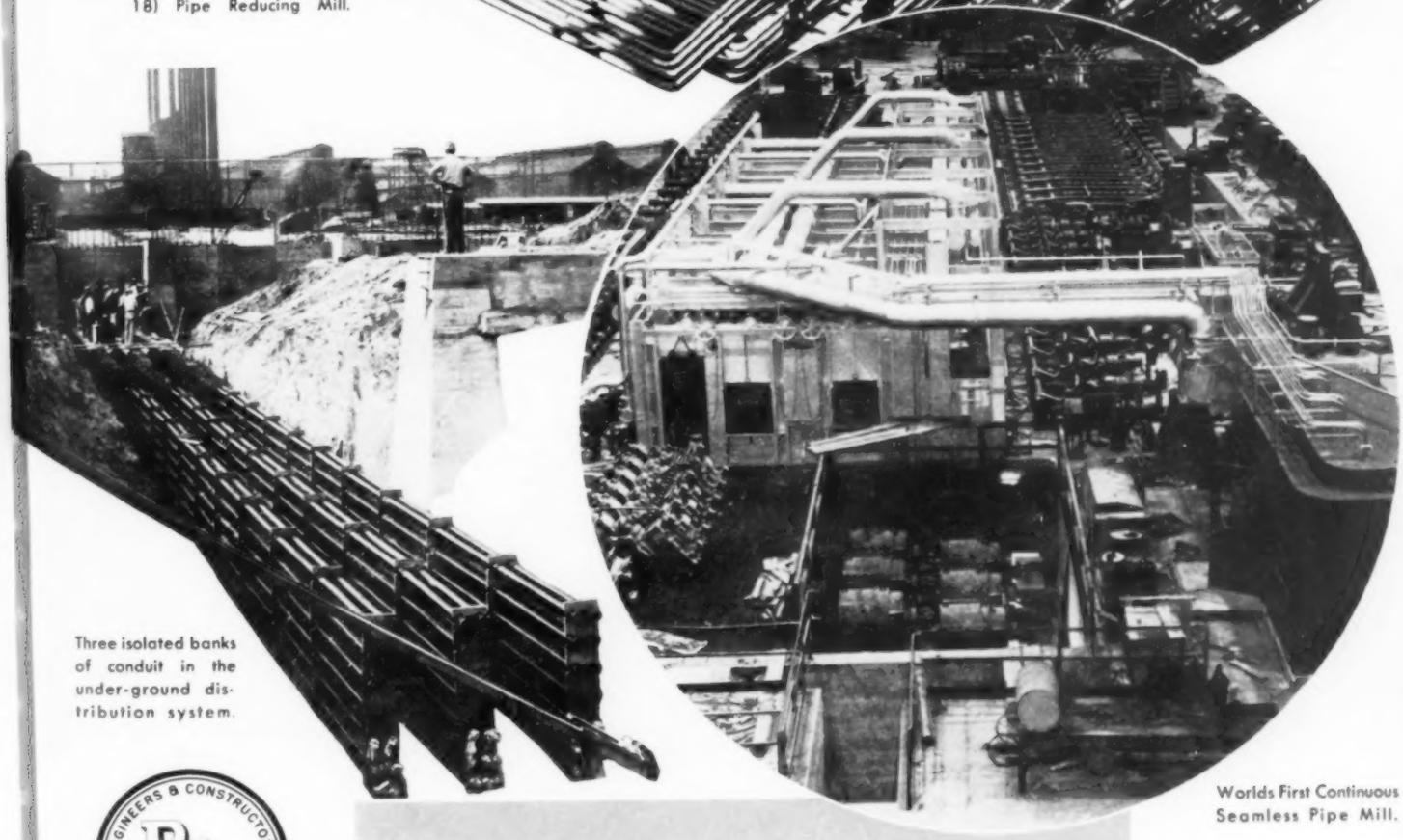
All Electrical Construction in these and other projects at

Windowless warehouse lighting with 10 f.c. at work levels.





Conduit runs and pull box for the 12 stand (future 18) Pipe Reducing Mill.



Three isolated banks of conduit in the under-ground distribution system.

Worlds First Continuous Seamless Pipe Mill.

ENGINEERS & CONSTRUCTORS PEC PITTSBURGH, PA.

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313 EAST CARSON STREET • PITTSBURGH 19, PA.

Write for illustrated Booklet

Lorain Works by

This big Cleveland semi-gantry crane, weighing 300 tons, serves four Bessemer converters, three of which are active. The fourth, visible at far right, is held for standby use. Each converter will produce 25 tons of steel in less than 20 minutes.

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

CLEVELAND ALL-WELDED GANTRY CRANE
AT NATIONAL TUBE COMPANY, LORAIN WORKS

The 125 ton single-leg gantry crane installed at the National Tube Company, Lorain, Ohio, in 1949, to serve the Bessemer converters, is unusual, not only because it is the largest of its type ever built, but also because of its shaftless bridge drive.

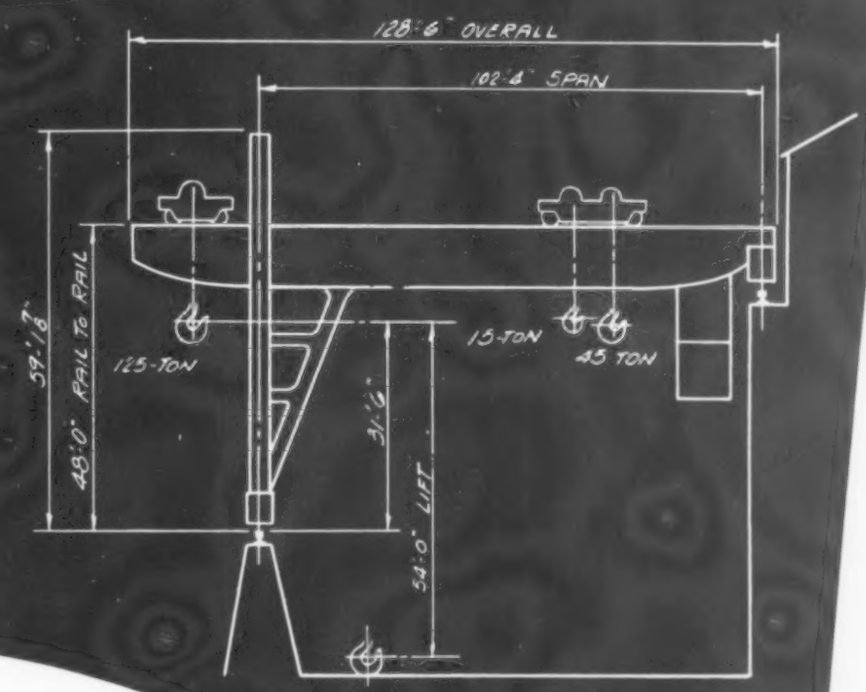
Heretofore bridge drives for all long span semi-gantries have employed motors, mounted on the bridge girders, arranged to drive the track wheels through line shafting, flexible couplings, bevel gears and universal joints. Most of these have been a source of maintenance difficulties to users.

The all-welded design of this crane, incorporating a welded box-section portal-type leg, provides maximum torsional rigidity to assure proper alignment of all parts and successful operation of the individual motor bridge drives. The hermetically sealed welded box sections used for both girders and leg, provide maximum resistance to corrosion, always a problem in the Bessemer area.

The bridge of the crane rides on eight equalizing-type two-wheel trucks, four of which are located at the gantry leg and four at the wall end of the crane girders. For each pair of trucks there is a direct connected individual motor drive, making four bridge drive motors in all. No provision is made to electrically synchronize the motors.

A variety of applications are being served by heavy-duty all-welded Cleveland Cranes of various types in mills of nearly all the important American steel producers.

THE CLEVELAND CRANE & ENGINEERING CO.
1131 EAST 289TH ST. • WICKLIFFE, OHIO



The crane is equipped with two trolleys, one with a 125 ton hoist and the other with a 45 ton and a 15 ton hoist. It is powered with 9 motors.

NATIONAL TUBE EXPANSION *

*At Lorain Works

BY T. J. ESS

The Lorain plant of the National Tube Co. actually had its inception at Johnstown, Pa., in 1888, when Tom L. Johnson and associates established the Johnson Steel Street Rail Co. for the manufacture of rails, frogs, switchwork, etc. Destruction of part of the plant by the Johnstown flood a year later, as well as the desire for a more favorable location, led to a study of other plant sites. In 1894, a site was selected on the Black River, about three miles from its mouth, near the village of Lorain, Ohio. Approximately one year later, pig iron melted in cupolas was blown in two 12-ton converters and the steel rolled in a 38-in. blooming mill and a rail mill.

In 1898, the Johnson Co. became the Lorain Steel Co. and construction was begun on two blast furnaces, an ore dock, and a second blooming mill. The following year the company became a subsidiary of the Federal Steel Co., which had been organized by Judge Elbert H. Gary with the Illinois Steel Co. as a nucleus. This became part of United States Steel Corp. upon its formation in 1901, and in 1903 the Lorain Steel Co. was renamed the National Tube Co. Construction of skelp mills and additional blast furnaces was begun.

Over the years, expansion and addition proceeded. In 1909, open hearth furnaces were put into operation; in 1918, by-product coke ovens; and in 1926, seamless tube mills. Today the 1442-acre site holds a completely integrated steel plant devoted almost entirely to the manufacture of tubular products. Rails, the original product upon which the plant was based, are no longer made.

The present plant may be divided into three main areas lying side by side, one including the coke plant, blast furnaces, open hearth and bessemer, the second, consisting of the rolling mills, and the third embracing all of the pipe mills.

RAW MATERIALS

Iron ore, coal and limestone comprise the principal incoming materials, and when operating at capacity, the plant will consume 2,880,000 gross tons of iron ore, 760,000 gross tons of limestone and dolomite, and 2,600,000 tons of coal annually. No outside scrap is used, the plant being self-sustaining in that respect due to the nature of its steel-making process.

Iron ore from the Lake ranges arrives at the plant by lake carriers, necessitating sufficient storage space to carry operations through the closed season of navigation. Lying along a bend in the river is a storage yard 3425 ft long × 355 ft wide, curving on a radius of about 1400 ft. Of the entire length, 2425 ft are fronted by the unloading dock, while 1000 ft do not have dock facilities but are served by railroad tracks. Ore vessels are unloaded by four unloading machines, two of 12-ton capacity and two newer ones of 20-ton capacity, which

dump either directly into railroad cars or into a trough situated immediately behind the machines. From the trough, the ore is stocked by three 10-ton bridges, which also reload ore from storage into railroad cars for use at the blast furnaces or for shipment to other plants.

The ore bridges permit storage in piles up to a height of 48 ft. The ore yard proper provides storage capacity for 1,618,000 gross tons of ore and 338,000 gross tons of limestone and dolomite. An additional 966,000 tons of ore may be placed in the storage area not served by the dock.

The iron ore is essentially of two types, with analyses averaging as follows:

	Basic		Bessemer	
	Wet	Dry	Wet	Dry
H_2O	11.94	.....	8.19	.....
SiO_2	7.36	8.36	9.08	9.82
Fe	49.57	56.63	54.27	59.11
Mn	0.93	1.06	0.35	0.38
P	0.067	0.076	0.030	0.033

Limestone and dolomite are received principally by boat, with analyses averaging as follows:

	Limestone	Dolomite
SiO_2	1.56	1.24
Al_2O_3+FeO	1.58	0.90
CaO	47.18	30.30
MgO	6.38	20.99
$CaCO_3$	75.13	54.09
$MgCO_3$	21.75	43.06
H_2O	2.15	0.15
P	0.008	.....
S	0.140	.....

Coal is not stored in the dock yard but near the coke plant in a separate storage 1705 ft long × 240 ft wide, with a capacity of about 350,000 tons.

Extensive improvements have been made on the half-mile curved dock along the Black River. Four unloaders and three ore bridges unload lake ore carriers and stock ore and limestone in the storage yard immediately back of the dock.

Coal is received in railway hopper cars and is unloaded by a 60 ft rotary dumper, with a capacity of 20 cars per hr, into a receiving hopper of 200-ton capacity. From this point, the coal may be moved either to storage or directly to the coke plant crusher building. If destined for storage, the coal is fed by vibrating feeders to a 48-in. conveyor belt which carries it to another 48-in. belt running along one side of the coal storage yard. Traveling tripper stockers discharge the coal to a height of about 20 ft at any desired location along the yard. From these primary piles, the coal is moved by a 10-ton coal bridge to permanent piles,

J. E. GOBLE
PRESIDENT

W. F. McCONNOR
EXECUTIVE VICE-PRESIDENT

which are continuously rolled down by a caterpillar tractor to prevent spontaneous combustion.

To recover coal from storage, the bridge picks up coal from the piles and deposits it in a hopper at one end of the bridge, from where it is fed to a series of conveyor belts which carry it to the crusher building.

This coal handling system operates at a rate of 600 tons per hr.

COKE PLANT

At the coke plant, coal is taken to the top of the crusher where it is fed through four 300-ton per hr coal breakers and passed over vibrating screens having ¼ in. × 3½ in. openings. Coal retained on these screens is put through four 250-ton per hr reversible hammer mills and then conveyed by a 48-in. belt to any of four 500-ton mixer bins. The fine coal passing through the screens by-passes the hammer mills and goes directly to the mixer bins. Pulverization is carried to a degree that 80 per cent of the coal passes through a ⅛ in. screen. From the mixer bins, the various grades of coal are proportioned by weight for the desired mixture by gravimetric type feeders and conveyed to the oven storage bins, of which there are three of 1800 tons, 2800 tons and 4000 tons capacity, respectively.

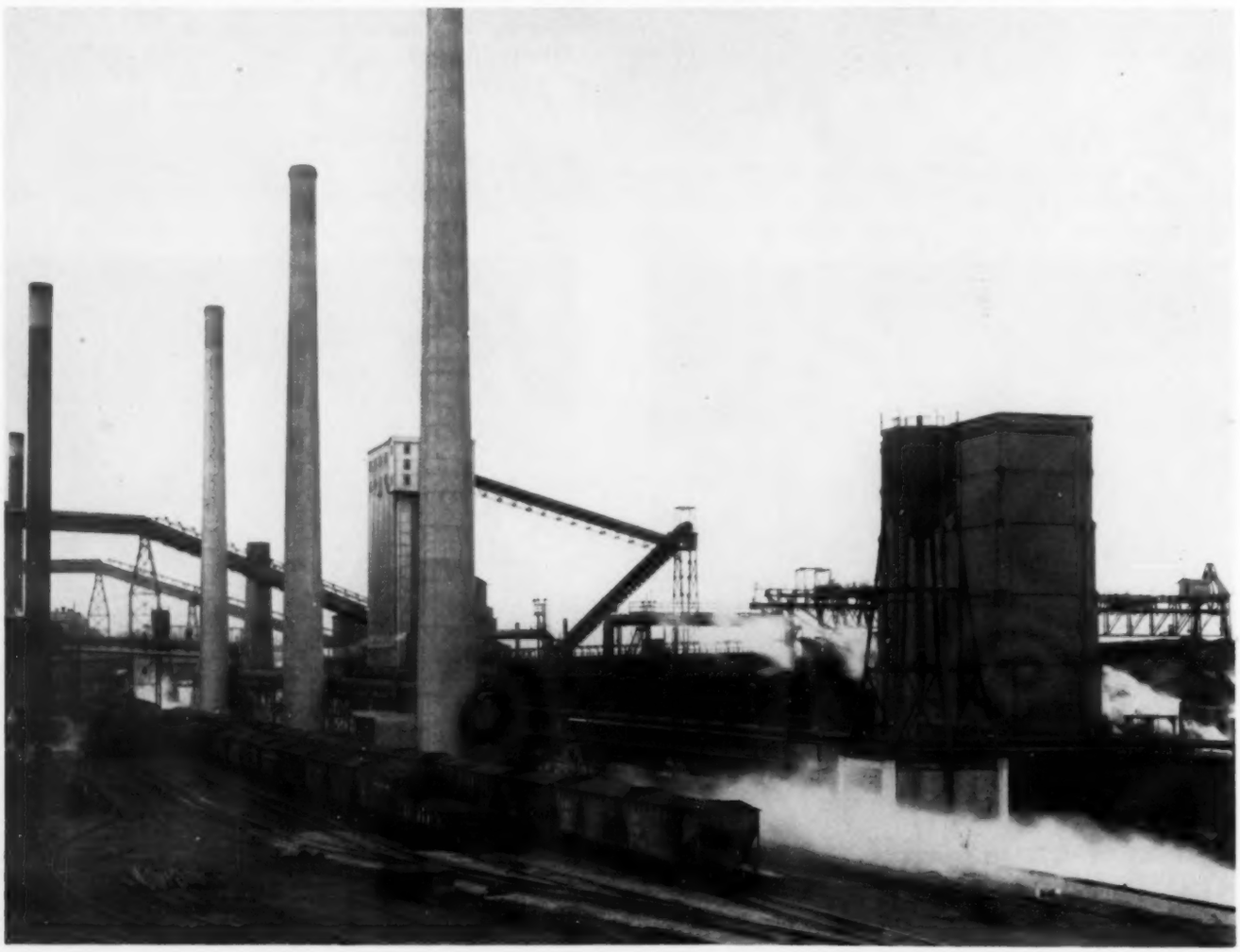
Seven batteries of coke ovens provide a coking capacity of 7050 net tons of coal per day. Four batteries of gun flue construction, located in one row, contain 52 ovens each, 37 ft 2 in. long, 9 ft 10⅜ in. high and 16¼–20¼ in. wide. Each of these ovens takes a normal charge of 12.1 net tons of coal. Doors are sealed by luting with clay.

The other three batteries, of more recent construction, form a second row and consist of 59 ovens each, 39 ft 4¾ in. long, 10 ft 1⅞ in. high and 17-21 in. wide. These ovens are of under-jet, high and low burner design, and take a normal charge of 13.3 net tons of coal. They are equipped with self-sealing doors.

All of the batteries are regenerative and are heated by straight coke oven gas, consuming about 43 per cent of the gas made. They operate with an oven pressure of 3-4 mm water column and oven flue temperatures of 2350-2500 F. Temperatures of waste gases at the battery stacks are 600-700 F. Coke is pushed at 1925-1950 F, with gross coking time ranging 16-18 hr.

The four batteries first mentioned are each served by a 4-hopper, gravity discharge, 12.5-ton charging larry car. Each battery also has a pusher machine carrying a rack-and-pinion operated ram, a cable-operated leveling bar and a motor-operated door extractor. On the coke side of these batteries is a motor-driven door machine carrying a hand-operated door extractor.

Coke is produced in seven batteries of by-product ovens with a total capacity for coking 7050 net tons of coal per day.



Each of the other three batteries is provided with a 3-hopper, 13.5-ton larry car with rotating bottom table discharge. These batteries likewise each have a pusher machine, but these do not carry a door extractor, the oven doors on the pusher side being handled by a separate motor-driven machine with hydraulically operated door extractor, duplicating the machine provided on the coke side.

Four quenching towers are provided, one located at each end of each row of batteries. They are of brick construction and of conventional design except for one which has a brick stack above the tower, extending 120 ft above the quenching track. Quenching is automatic, with electric timers, the water coming from the primary coolers. The two towers serving the newer batteries recirculate the quenching water and are each equipped with forty 4-in. iron spray nozzles.

Two coke wharves are installed for the row of four batteries and one wharf for the row containing three batteries. Coke is carried from each wharf by 42-in. belts to an elevated junction house, where it is transferred to one 60-in. conveyor belt leading to the top of the screening station. Here are three complete lines consisting of scalpers, crushers and vibrating screens. The scalpers are 5 ft wide and contain five shafts with 12 in. × 1 in. discs, and have 4-in. square screen openings. Each scalper has a capacity of 200 tons per hr. Crushers, each of 80 tons per hr capacity, contain two 36 in. × 48 in. segmented spike-toothed rolls with 3-in. setting. The single-deck gyrating screens, 60 in. × 192 in. with 1½ in. square openings, screen the furnace coke at a rate of 200 tons per hr each, while double-deck screens with ¾ in. and ⅜ in. square openings separate the domestic, pea and breeze sizes at a rate of 50 tons per hr. Furnace coke, domestic coke, pea coke or breeze may then be loaded through boom conveyor loaders directly to standard hopper cars, or they may be sent to storage bins.

The coal mix normally charged to the ovens consists of 50 per cent low volatile coal and 50 per cent high volatile coal. The low volatile coal is Pocahontas from mines in West Virginia, owned by United States Steel Corp. About 20 per cent of the high volatile coal comes from the corporation-owned Lynch mine in Kentucky, while the remainder of the high volatile coal is purchased in the open market from various sources.

Complete equipment is installed for the recovery of the usual by-products. Gas first passes through ten indirect water cooled primary coolers, each with a capacity of 10,000,000 cu ft of gas per day. There are four centrifugal turbine-driven exhausters, each with a capacity of 29,750 cfm, having crank-type cylinder governors, arranged for parallel operation from a master controller. Electric precipitators are installed following each exhauster. Gas then travels through reheaters to two lead-lined, tile-packed ammonia scrubbers, 16 ft in diameter × 40 ft high, each having a capacity of 90,000,000 cu ft of gas per day.

Ammonium sulphate is recovered in a plant having a capacity of 90 tons of sulphate per day and containing two vaporizers, two crystallizers and two drum type dryers, with the necessary circulating pumps, slurry pumps, fans and exhauster. One ammonia still, of 200,000 gal per day capacity, is designed to pass all ammonia gas into the coke oven gas ahead of the ammonia scrubbers or to furnish ammonia gas to the pyridine recovery plant.

Three new batteries of coke ovens were included in the overall expansion program at Lorain. Each of these batteries consists of 59 under-jet, high-and-low burner ovens, each oven taking a charge of 13.3 net tons of coal.

The gas next passes through three final coolers, 16 ft in diameter × 80 ft high, containing grids of yellow pine, and then through three light oil scrubbers 23 ft in diameter × 87 ft high. These scrubbers contain steel sheet packing spaced ½ in. apart. Two of the units are equipped with entrainment arrestors consisting of 4 in. × 4 in. cross partition type chemical stoneware stacked 3 ft high.

The gas, now free of all by-products, flows to a 40,000 cu ft gas holder. From the holder, fuel gas flows to the ovens for heating, while surplus gas is sent to the steel plant for use in open hearth and heating furnaces. Three turbine-driven centrifugal boosters, rated at 20,700 cfm, 8-psi pressure, handle the surplus gas to the mills. Orifice meters measure the total gas leaving the benzol plant, the fuel gas used by each oven battery, the gas to the mills and the gas wasted to the bleeder. No sulphur removal is carried out.

Two light oil stills, affording a total capacity of 65,000 gal of wash oil feed per hr, free the light oil from the wash oil. The light oil is then processed through an 8 ft × 40 ft continuous crude residue removal column containing ten trays on 2 ft centers, a 4 ft × 80 ft continuous fore-running column containing 36 trays on 22 in. centers, a 4 ft × 50 ft continuous pure still residue removal column containing 12 trays on 22 in. centers, a 4 ft × 80 ft continuous pure benzol column, containing 36 trays on 22 in. centers, a 6 ft × 60 ft batch-type pure product unit containing 30 trays on 22 in. centers, and a 6 ft × 72 ft batch-type crude

solvent and naphthalene unit containing 36 trays on 22 in. centers. Fractionation is carried out to produce motor benzol, pure benzol, pure toluol, pure xylol, solvent naphtha, crude heavy solvent and naphthalene.

Equipment is also provided for the absorption of phenol from weak ammonia liquor and for the recovery of pyridine from the circulating ammonia liquor.

Coke yields run 72 per cent furnace coke, 1 per cent pea coke and 5 per cent coke breeze. By-product recovery averages 11,500 cu ft of gas, 16 lb of ammonium sulphate, 2.7 gal of crude light oil, 2 lb of naphthalene and 5½ gal of tar per ton of coal charged. Fractionation of the light oil gives approximately 14,000 gal of pure benzol, 1330 gal of toluol and 200 gal of xylol per day.

BLAST FURNACES

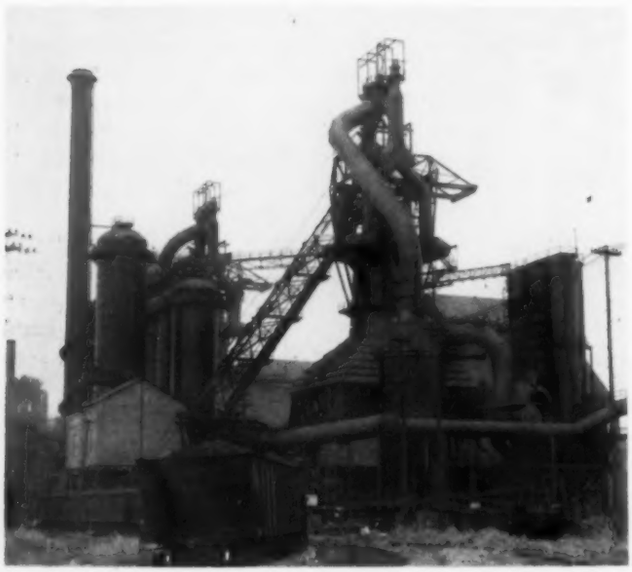
Five blast furnaces, details of which are given in Table I, produce pig iron for use in the open hearth and bessemer departments. Two grades of iron are made for these purposes, with analyses about as follows:

	Basic	Bessemer
Silicon	0.90-1.30	1.20-1.50
Sulphur	0.03 max	0.03 max
Phosphorus	0.15	0.07
Manganese	1.75	0.60

Approximately 60 per cent of the iron produced is of bessemer quality, and 40 per cent basic. The overall coke rate is about 1700 lb per net ton of iron.

The furnaces are placed in a single row and employ a common high line. Furnace filling is done by motor-driven, single drum, double skip hoists, with charging sequences of OSC/OCC, OSCOCC/, OSCC/OCC, OSCCOCC/, and variations. Ore and stone are charged by weight, and coke by volume. The ratio of stone to mix in the charge ranges 4.2–4.7, while the fuel ratio runs 2.0–2.4. Each furnace is equipped with a revolving top distributor. Two of the furnaces are equipped with charging control systems which automatically govern the filling of the skip car with coke, the starting of the skip hoist, the operation of the revolving distributor, the dumping of the bells, the operation of the stockline recorder, etc.

Two of the five blast furnaces at Lorain are large units, with hearth diameters of 26 ft and 27 ft-6 in., respectively. Both of these furnaces have hearth walls and bottom pads of carbon.



Four of the blast furnaces have carbon hearth walls and bottom pads which were installed in 1946 and 1948, all with carbon iron notches. One furnace (No. 4) suffered an iron notch breakout after about five months operation. This was patched with carbon brick and carbon paste, and put back in operation after a six-day outage. This furnace has now produced about 850,000 tons of iron. Another carbon hearth furnace (No. 3) has produced approximately 1,700,000 tons of iron, one of the highest tonnages now on record for American carbon installations.

Blast is furnished to the furnaces by three turbo-blowers rated at 60,000 cfm, 30 psi; one turbo-blower rated at 80,000 cfm, 30 psi; and five steam engines rated at 28,000 cfm, 30 psi. All of these units operate on 250-psi steam pressure.

Blast is heated in two-pass, side combustion stoves as listed in Table I. All of the checkerwork in the stoves is of basket weave construction with 4½ in. × 4½ in. flues. The stoves of No. 3 and 4 furnaces also have 3-in. ball inserts, and operate with waste gas temperatures of 250-275 F, as compared with 520 F for the other stoves. Gas is burned in pressure type proportioning burners on all stoves. Approximately 20 per cent of the total gas made is used by the stoves, with an operating cycle of 6 hr on gas, 2 hr on blast. Blast temperatures are controlled automatically.

Gas from the furnace tops contains approximately 15 grains of dust per cu ft, which is reduced to about 5 grains per cu ft in the dust catcher. Each furnace is provided with a dust catcher 29 ft 3 in. in diameter × 36 ft high. All of the furnaces except No. 4 are also equipped with whirlers 13 ft 6 in. in diameter × 50 ft high, which further reduce dust content to about 2 grains per cu ft. Next the gas passes through a wet washer tower 12 ft in diameter × 82 ft high, where dust is reduced to 0.10-0.25 grains per cu ft. In addition, there is one electrical precipitator which can be used on the gas from either No. 3 or No. 4 furnace. This unit takes 40 per cent of the gas from one furnace, cleaning it to 0.01 grains per cu ft for use on the stoves of No. 3 and 4 furnaces, which have the checker inserts. Four disintegrators are also provided, further cleaning about 20,000 cfm of wet-washed gas for use in gas engines.

Surplus gas is used for boiler fuel and in gas engines driving electric generators. A 100,000 cu ft holder acts as a reservoir between the disintegrators, and the gas engines.

Dust-laden water from all of the gas washers flows to two thickeners 120 ft in diameter × 14 ft deep. This sludge, mixed with dry flue dust, is sintered in a machine of 750 tons per day capacity. This unit is 76 ft 6 in. × 72 in., with 12 wind boxes, and is provided with an 8 ft double inlet fan that produces a suction of 16.5 in. water column.

Iron is tapped into 70-ton open top ladles or closed ladles, and transferred either to the open hearth or the bessemer department. If not needed there, it may be

TABLE I

BLAST FURNACE DATA

Furnace number	1	2	3	4	5
Hearth diameter, ft-in.	23-0	23-3	26-0	27-6	22-3
Bosh diameter, ft-in.	25-9	26-0	29-6	31-0	25-0
Stockline diameter, ft-in.	19-0	19-0	20-0	20-0	18-9
Crucible height, ft-in.	11-0	11-0	12-0	11-9	11-0
Bosh height, ft-in.	9-0	9-0	11-9	11-9	9-0
Straight section height, ft-in.	9-0	9-6	8-6	5-6	17-0
Inwall section height, ft-in.	44-6	43-0	54-5¼	57-5¼	36-6
Stockline section height, ft-in.	8-9	9-3⅞	6-6¾	6-6¾	8-3⅞
Total furnace height	89-10	89-10	105-6	105-6	89-10
Height, bottom to iron notch, ft-in.	2- 6¾	2- 6¾	1-11¼	1- 8¼	2- 6¾
Height, iron notch to cinder notch, ft-in.	3-10¼	3-10¼	4-11¾	4-11¾	3-10¼
Height iron notch to tuyeres, ft-in.	6-11¼	6-11¼	8-3¾	8-3¾	6-11¼
Bosh angle, deg—min—sec	81-18-50	81-18-50	81-31-44	81-31-44	81-19-0
Inwall slope, in. per ft	0.9101	0.9767	1.047	1.047	1.028
Number of tuyeres	15	16	16	18	16
Lining thickness in crucible, ft-in.	2-7½	2-7½	3-4½	3-0	2-11½
Lining thickness in bosh, ft-in.	2-0	2-6	2-7½	2-7½	2-7½
Lining thickness in stack, ft-in.	3-7½ to 2-1	¾ to 2-7½	4-10½ to 3-9	4-1½ to 3-0	3-10 to 2-3
Lining thickness in throat, ft-in.	1-10½	2-3	3-5⅞	3-0	1-10½
Stack working volume, cu ft	28,712	29,043	41,505	45,069	28,214
Hearth cooling, cast iron plates, number	21	20	24	25	20
Hearth cooling, cast iron plates, ft-in.	12-4	12-5	15-5	15-5	12-4
Bosh cooling, rows of copper plates	6	6	8	8	6
Stack cooling, rows of copper plates	7	7	8	8	7
Stockline protection, rows of steel plates	6	5	12	12	6
Number of gas offtakes	4	4	4	4	4
Diameter offtakes, inside, ft-in.	4-3	4-9	5-0	5-0	4-3
Bell operation	Electric	Electric	Air	Air	Steam
Number of stoves	4	4	4	4	3
Stove diameter, ft	22	21	21	21	23
Stove height, ft	120	120	120	120	120
Heating surface per stove, sq ft	87,821	74,895	128,060	130,462	98,406
Blast volume, average, cfm	60,000	60,000	80,000	85,000	60,000
Blast volume, maximum, cfm	63,000	63,000	84,000	90,000	64,000
Blast temperature, average, F	1050	1000	950	1050	1000
Blast temperature, maximum, F	1300	1200	1050	1100	1100
Blast pressure at tuyeres, psi	17.5	17.0	17.5	18.5	16.0
Furnace top temperature, F	295	300	450	400	290
Furnace top pressure, in. water	49	50	50	58	48
Casting period, hr-min	4-45	4-45	6-0	6-0	4-45
Iron produced, tons per day	931	951	1189	1330	871

put over either of two double-strand pig machines carrying 324 molds on each strand. Some hot metal is also sent to the plant foundry in 40-ton ladles.

Slag is run into ladles and transported to a dump at the west end of the plant, where it is later loaded by two 95-ton steam shovels into trucks and taken to nearby slag crushers which will normally produce 3000 tons of graded slag per 24 hr. The slag is crushed and graded to meet specifications for road-building, and is then put back in stock piles until shipped. Some slag is also sold to be processed into light aggregate. Slag weight runs about 950 lb per net ton of iron.

E. G. PRICE
VICE-PRESIDENT, OPERATIONS

J. L. YOUNG
VICE-PRESIDENT, ENGINEERING

ROBERT URQUHART
GENERAL SUPERINTENDENT
LORAIN WORKS

OPEN HEARTH

Steelmaking facilities include both basic open hearth furnaces and acid bessemer converters, with annual rated capacities of 1,350,000 tons for the former and 900,000 tons for the latter.

Open hearth furnaces are housed in a building 1025 ft long, consisting of three adjacent bays: the pouring bay, 64 ft 3 in. wide; the charging bay, 83 ft 6 in. wide; and a leanto 45 ft wide. Three 12-ton floor type charging machines, one 125/25 ton hot metal crane and two 75/15 ton hot metal cranes operate in the charging bay, while three 200-ton ladle cranes serve the pouring bay.

At one end of the open hearth building is a 300-ton barrel type hot metal mixer, served by a 75-ton crane, and a 560 ft × 80 ft stockhouse containing three cranes, two rated at 10 tons and one at 7½ tons. Hot metal is poured from the mixer into 50-ton ladles which are then moved by ladle cars and electric locomotives to the furnace to be charged.

There are 12 stationary open hearth furnaces, each rated at 156 tons. Seven of these have hearth dimensions of 45 ft × 15 ft 6 in., and five, of 40 ft × 15 ft 6 in. The furnace bottoms, totaling about 36 in. in thickness, are composed of a ⅝ in. bottom plate, ½ in. of insulating cement, 2½ in. of insulating brick 4½ in. of first quality firebrick, 11½ in. of chrome brick, 2 in. of plastic chrome cement, and 15 in. of sintered magnesite. The backwalls are of sloping constrnction, with a 3 ft 6 in. offset. The sprung arch roofs are of silica brick, 12 or 15 in. thick with, respectively, ribs of 18 or 21 in. Chrome-magnesite brick is used at the bottom of frontwall piers. Chrome brick is used for frontwall piers and arches, backwalls, and on the burner blocks. Outside end walls are of silica brick.

Each uptake is 4 ft 9 in. × 6 ft 6 in., giving an area of 30.8 sq ft at each end of the furnace leading to a 13 ft × 16 ft slag pocket.

Regenerator chambers are constructed in two separate sections at each end of the furnace, with independent walls and roofs. Inside dimensions are 31 ft 3 in. in length × 10 ft 10 in. and 7 ft 11 in. in width, respectively. Checkerwork is built of 3½ in. × 4 in. × 13 in. brick on the support arches to a depth of 8 ft 4 in. (25 courses of 4 in.). Checker flues are 9½ in. × 9⅞ in. The length of the checkerwork is divided into two sections by a 13½ in. wall so as to leave a length of 23 ft at the fantail end of the chamber and 7 ft 1½ in. of length at the bulkhead end. When a rebuilt furnace is first started, only the large sections of checkerwork, with a volume of 3560 cu ft on each end of the furnace, are used, while the small sections, 1100 cu ft, are covered over with thin brick. When the main checkerwork begins to clog, the covering is removed from the top of the auxiliary sections.

An insulating plaster is applied to exterior surfaces of the regenerators and slag pockets.

The furnaces are fired with a combination of liquid and gaseous fuels, the total input over a typical period of time being made up of the following:

	Per cent
Tar	54
Fuel oil	22
Coke oven gas	13
Natural gas	11

The water-cooled combination burners are 9 ft 10 in. long and 10¾ in. outside diameter, and have a 4-in. gas outlet and a 1¼ in. outlet for the atomized oil stream.

Liquid fuel may be pumped direct from the coke plant or may be received in tank cars. Two 25,000 gal storage tanks are installed at the open hearth where the liquid fuel is maintained at 150 F. Steam driven duplex pumps move the oil or tar through their separate circulating systems in the open hearth shop. Individual heaters at each furnace further raise temperatures to 220 F for fuel oil and 190 F for tar.

Each furnace is equipped with automatic furnace pressure control and recorder, an integrating and recording gas meter, an integrating liquid fuel meter, pressure gages for liquid fuel and atomizing steam, a micrometer valve for regulating the flow of liquid fuel, and an air-actuated steam valve for steam control and reversal. The liquid fuel valves are automatically reversed when atomizing steam valves are manually reversed. Gas valves are reversed manually, and dampers are motor-operated. Air supply, atomizing steam and liquid fuel are all interlocked to insure proper operation.

In addition, a complete automatic furnace reversal system has been installed on one furnace, and a modified reversal system on two others. Two furnaces are equipped with automatic fuel input control based on roof temperatures. Forced draft has been applied to only one furnace.

Furnace charges average 340,000 lb, and may range 37-68 per cent hot metal, 2-3 per cent cold iron, and 60-30 per cent steel scrap. The iron may contain 0.90-1.30 per cent silicon, 0.016-0.029 per cent sulphur, 0.200 per cent maximum phosphorus, and approximately 1.75 per cent manganese.

Steel is produced in a broad range of grades, including killed steels of 0.10-1.00 per cent carbon, semi-killed steels of 0.10-0.23 per cent carbon, and mechanically capped steels of 0.05-0.24 per cent carbon. Low carbon rimmed and capped grades are tapped without a furnace addition. On killed grades a block addition of 10 per cent silicon, pig iron or silicon-aluminum — titanium is made to stop the carbon-oxide reactions at any desired point. Some grades use no form of silicon block but depend solely on the deoxidizing action of a furnace manganese addition. Ladle additions are based upon deoxidization treatments as dictated by metallurgical considerations. Times of heats average 10 hr 15 min, charge to tap, and 11 hr 35 min, tap to tap, giving a production rate of 16 tons per furnace per melting hour, or 14.16 tons per furnace-hour overall.

Average consumption of miscellaneous materials runs as follows:

	Lb per net ton of steel
Fluxes	
Limestone	115
Fluorspar	3
Dioxidizers	
Manganese	20
Titanium	1
Aluminum	1
Silicon	11
Sil-Alum-Titanium	2
Ferro-Alloys	
Phosphorus	0.3

A major item in the Lorain expansion is the completely new bessemer converter installation, which is housed in the group of light-colored buildings at the center of this photograph.

Two motor-operated dolomite machines are used to facilitate furnace bottom maintenance.

Steel is tapped into 170-ton ladles and poured at any one of three pouring platforms into open top molds 24-32½ in. × 27-32¼ in. × 82-94 in. (11,280-22,070 lb), big-end-up molds 22 in. × 32 in. × 83 in. (19,450 lb), or bottle-top molds 30¼ in. × 30¼ in. × 77 in. (16,000 lb), as dictated by product requirements. For rimmed and capped grades, the molds are sprayed internally with graphite in water, while dry pitch is blown on the inner surfaces of molds to be used for killed or semi-killed steels. This conditioning is performed in a nearby mold yard 273 ft long × 79 ft 6 in. wide, which is adjacent to a stripping department, a cinder yard and a skullcracker. The cinder yard is served by one 50-ton crane and two 25-ton cranes, and the skullcracker by one 10-ton crane. The stripping area, with two other installations nearby, provides four 200-ton strippers.

Open hearth slag, which averages about 350 cu ft per heat, is run into slag pots and dumped in the cinder yard, where the slag is processed by magnet to recover the metallics, then screened for the blast furnaces. Rubbish is dumped for fill elsewhere in the plant.

A water-tube waste heat boiler, rated at 540 hp and containing 8396 sq ft of heating surface, has been installed on each furnace. Induced draft fans, half driven by 125-hp motors and half by 100-hp steam turbines, are rated at 150,000 lb of 500 F gas per hr.

Located near the open hearth is a foundry department containing a 60-in. cupola, four rotary bronze furnaces and one babbitt furnace, with the necessary pattern storage, ladles, molding machines, core drying ovens, sand handling and conditioning equipment, etc. The cupola produces about 500 tons of gray and alloy iron for castings, while approximately 6500 tons of iron direct from the blast furnaces is used for molds and stools. Each month this department turns out approximately 450 ingot molds, 300 mold stools, 200 tons of reeler plugs, 400 tons of iron castings, 35 tons of brass castings, 5 tons of copper castings and 10 tons of cast babbitt.

BESSEMER DEPARTMENT

Bessemer steel has played an important role in the operations of National Tube Co., and the process has been developed to a high degree of uniformity and quality. Just recently, a complete new bessemer department was built, which is now the most modern installation of its kind in the country.

Two 800-ton barrel type mixers of welded construction are installed side by side in a mixer building 120 ft × 85 ft, served by a 125/30-ton ladle crane. Center lines of the mixers are 48 ft 6 in. above ground level. On one side of the mixer line is the track where incoming ladles of hot metal arrive, while at the other side is a track for the transfer ladle car that takes iron to the converters. Both of these tracks are 22 ft 6 in. above ground level.

Incoming iron arrives in 70-ton ladles of the type that can be picked up by crane and dumped into the mixer. The mixer tilts to pour iron into 35-ton transfer ladles for the converters. The transfer car is also of tilting design, and is controlled from a pulpit, as is the tilting scrap car which operates on the same track.

At present, there are three 25-ton converters installed in a row on 45 ft centers, with additional space provided for two more. These vessels, of welded construction, have a shell diameter of 12 ft, and an internal diameter of 9 ft 4 in. The noses of the vessels are lined with rammed ganister, the shoulders with a silica firestone, and the bodies with a harder firestone of higher silica

content. Converter bottoms are rammed with wet ganister and contain 40 pieces of tile. Of these, 31 are tuyeres, each containing seven 5/8 in. holes. Bottoms last for about 24 blows, and converter linings last 625-675 blows.

The converter trunnions are centered 24 ft 6 in. above ground level. On one side is the charging platform carrying the track leading from the mixers, while at the other side, 18 ft above ground level, is a repair track over which runs a shielded repair car. The converter bay is 270 ft × 102 ft 4 in., and is served by a 125/45-ton semi-gantry crane.

Running across one end of the converter bay is a 175 ft × 75 ft scrap yard containing a 15/5-ton crane, where scrap can be loaded directly into the tilting scrap car previously mentioned.

Converters are blown by three turboblowers, rated at 40,000 cfm at 30 psi pressure, each individually connected to a converter, but so piped that they may be shifted from one vessel to another. The blowers are equipped with constant-pressure and minimum-volume regulators. Volume of the blast may be throttled by adjustment of double seated air valves controlled from the operating pulpit. An idle blow control is also provided that permits the blower to operate at reduced speed when the vessel is tipped for pouring, without letting blower speed fall below the pumping range. Blowing pressure usually ranges 24-26 psi.

When the blow is finished, the converter is tilted over so as to pour the steel directly into 80-ton ladles on cars spotted below on a track running the length of department at ground level. Normally, two blows are put into one ladle, making a 60-ton heat. This ladle car is then shifted into the adjacent pouring building, 513 ft × 75 ft 6 in., where two teeming platforms are provided, served by two 125/45-ton ladle cranes.

Running beneath each converter at right angles to the converter line is a stub-end track over which slag cars operate and bottom jack cars remove worn-out converter bottoms and bring up new ones. The old bottoms are shifted to an adjacent bottom house 250 ft long × 100 ft wide, containing a 35/15-ton crane. Relined bottoms are dried out in a gas-fired oven, 151 ft long, with a capacity for 11 bottoms, each carried by an individual car. Oven temperature is automatically controlled.

Iron coming to the bessemer department ranges 1.10-1.50 per cent silicon, 0.45-0.60 per cent manganese, 0.05 per cent maximum sulphur, and 0.07 per cent maximum phosphorus. The average charge is 30 tons, and the blow averages 16-18 min in length. Steel produced ranges 0.06-0.55 per cent carbon, 0.20-1.00 per cent manganese, up to 0.30 per cent silicon, 0.015-0.350 per cent sulphur, and 0.06-0.10 per cent phosphorus. It is poured into ingots of 30¾ × 30¾ × 78 in. or 32½ × 32½ × 94 in. About one-third of the bessemer production is killed steel for seamless tubes.

BLOOMING AND BILLET MILLS

Primary rolling mills now consist of two blooming mills, with some accompanying secondary mills. One of these is the new No. 4 mill installation, consisting of a 46-in. bloomer, followed by a 38-in. reversing mill, a six-stand 30-in. mill and a four-stand 20-in. mill, in a layout that affords high tonnage with a high degree of flexibility. Two old 38-in. blooming mills and a rail mill were replaced by the new unit.

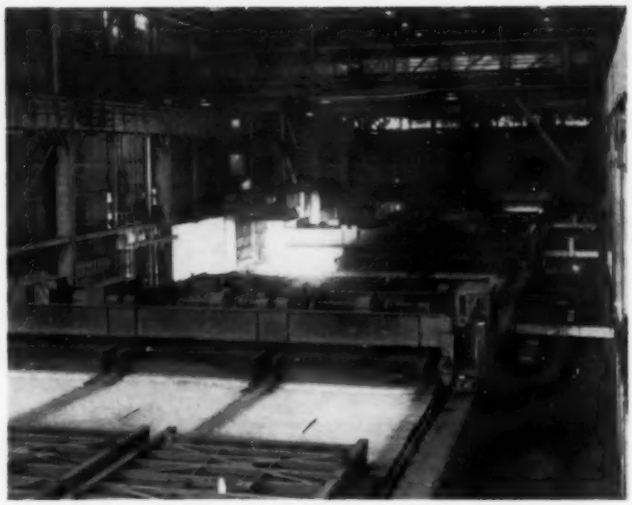
Heating facilities for the new No. 4 mill consist of eight rows of bottom-fired recuperative soaking pits of three holes each. Each hole, 12 ft 6 in. wide × 15 ft long and 12 ft deep, is provided with two refractory tile recuperators capable of heating combustion air to temperatures of 1400 F or more. The air is blown through the recuperators of each pit by a fan rated at 6000 cfm, 70 F, 5.85 in. water column. Temperature of the waste gases is reduced to 400-500 F in passing through the recuperators.

Coke oven gas and preheated air are introduced through a single burner located in the center of the bottom of each pit, the flame traveling up, turning down and passing around the ingots in the pit, and exiting through four flues, one in each bottom corner of the pit. Complete control equipment provides regulation of furnace temperature, furnace pressure, and gas-air ratio.

Temperature of ingots charged into the pits varies somewhat in accordance with their track time, but in

Hot metal of conventional bessemer analysis comes to the bessemer department in 70-ton ladles, which are picked up and dumped into either of two 800-ton mixers.

Three 28-ton converters, installed in a row on 45-ft centers, produce approximately 135 tons of bessemer steel per hour. Space has been provided for two additional vessels.



Twenty-four bottom-fired recuperative soaking pits serve the new blooming mill, providing a total hearth area of 3500 sq ft. They are fired with coke oven gas.

general the ingots still retain a rather high degree of heat. The heating time required usually ranges 4-5½ hr.

Ingots are handled into and out of the pits by three 15-ton pit cranes of 95 ft 2 in. span. The heated ingots from the pits are carried by two ingot buggies, which convey them to the mill approach table at speeds up to 238 and 321 fpm respectively. Here the buggy is automatically stopped by limit switches, and dumps the ingot upon the table, where a scale for weighing and a turntable are installed. The table extends 112 ft 11 in. to the blooming mill.

This blooming mill is a 46-in. two-high reversing unit, with closed top housings having posts 36 in. × 17 in. The cast alloy steel rolls are 100-in. in body length, and have a roll collar diameter of 46 in. and a minimum diameter of 38¼ in. at the bottom of pass grooves. Passes of 34, 20, 15 and 8 in. width are provided. The rolls run in oil film bearings with roller thrust bearings, and are balanced by a hydraulic system operating at 1250-psi pressure.

Mill screws, 15 in. in diameter with 2-in. pitch, are driven by two 150-hp, 230-volt d-c mill type motors at speeds that afford a roll lifting speed of 19-38 fpm. Roller bearings are installed throughout the entire screwdown mechanism.

Double rack type cast steel sideguards are provided on each side of the mill, driven through pinions and speed reducers by four 100-hp, 230-volt d-c mill type motors. Manipulator fingers are installed on each side of the mill, also driven by 100-hp mill type motors. Front and back mill tables are each driven by two 150-hp motors, while feed rollers are driven by a 50-hp motor.

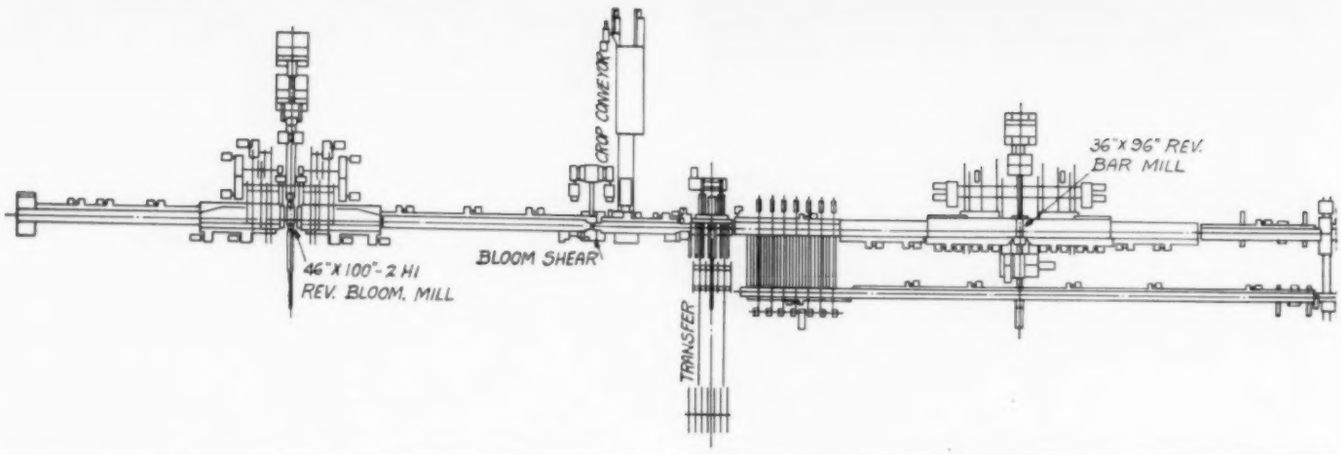
No mill pinions are installed on this unit, as the drive is a twin-motor arrangement operating directly from the motors through universal spindles of 19 in. diameter running in bronze half-slippers. Each main drive motor is a 4000-hp, 40-80-rpm, 800-volt, d-c reversing unit, operating under adjustable voltage control with maximum torque of 1,180,000 ft lb at 0-38 rpm. A maximum delivery speed of 800 fpm is available. Power to the motors is supplied from a motor-generator set composed of two 3500-kw, 800-volt d-c generators driven at 357 rpm by a 6000-hp, 13,800 volt induction motor. This set carries a steel plate flywheel 180 in. in diameter, weighing 164,000 lb.

Auxiliaries of the 46-in. mill, including front and back mill tables, feed rollers, screwdowns and side guards, operate under variable voltage control, their drives receiving power from two motor-generator sets, each comprised of eight 250-volt d-c generators totaling 810 kw, driven by a 900-hp, 1200-rpm, 2300-volt synchronous motor.

Following the 46-in. mill at a distance of 145 ft is a down-and-up-cut shear capable of cutting sections up to 15 in. × 15 in. and driven by two 350-hp motors under variable voltage control. The shear gage is a motor-operated movable carriage supported above the shear runout table on I-beams, adjustable for lengths ranging from 9 ft to 32 ft 8 in. Bloom crops from the shear fall down a chute into a crop car which is submerged in water. The car is hoisted by cables up an incline, at the top of which the car dumps its contents directly into railroad cars.

Leaving the 46-in. mill, the bloom may be removed over a transfer car to the adjacent stockyard, or it may be taken over a transfer to a parallel mill line leading to a six-stand billet mill, or it may proceed straight down the table to a 38-in., two-high reversing bar mill located 351 ft beyond the bloomer. This unit is essentially a small blooming mill, with rolls of 40 in. diameter × 96 in. body length, operating in oil film bearings. These rolls contain passes of 15 in., 12 in., and 9 in. width, as well as an octagon leader pass and a round finishing pass, and receive 15 in. × 15 in. blooms in lengths of 11-28 ft (7656-19,488 lb). A 22 ft length is typical. The top roll is balanced hydraulically and has a maximum lift of 24¾ in. Mill screws are 12 in. in diameter with 2 in. pitch, and are both operated by a single 100-hp, 230-volt d-c mill type motor under variable voltage control. On each side of the mill are sideguards driven under variable voltage control by four 75-hp motors, and manipulator fingers actuated by two 75-hp motors with constant voltage control. Also on each side of the mill are integral guide units, consisting of conventional guides and strippers mounted in guide boxes. These are changed when the rolls are changed, and the design is

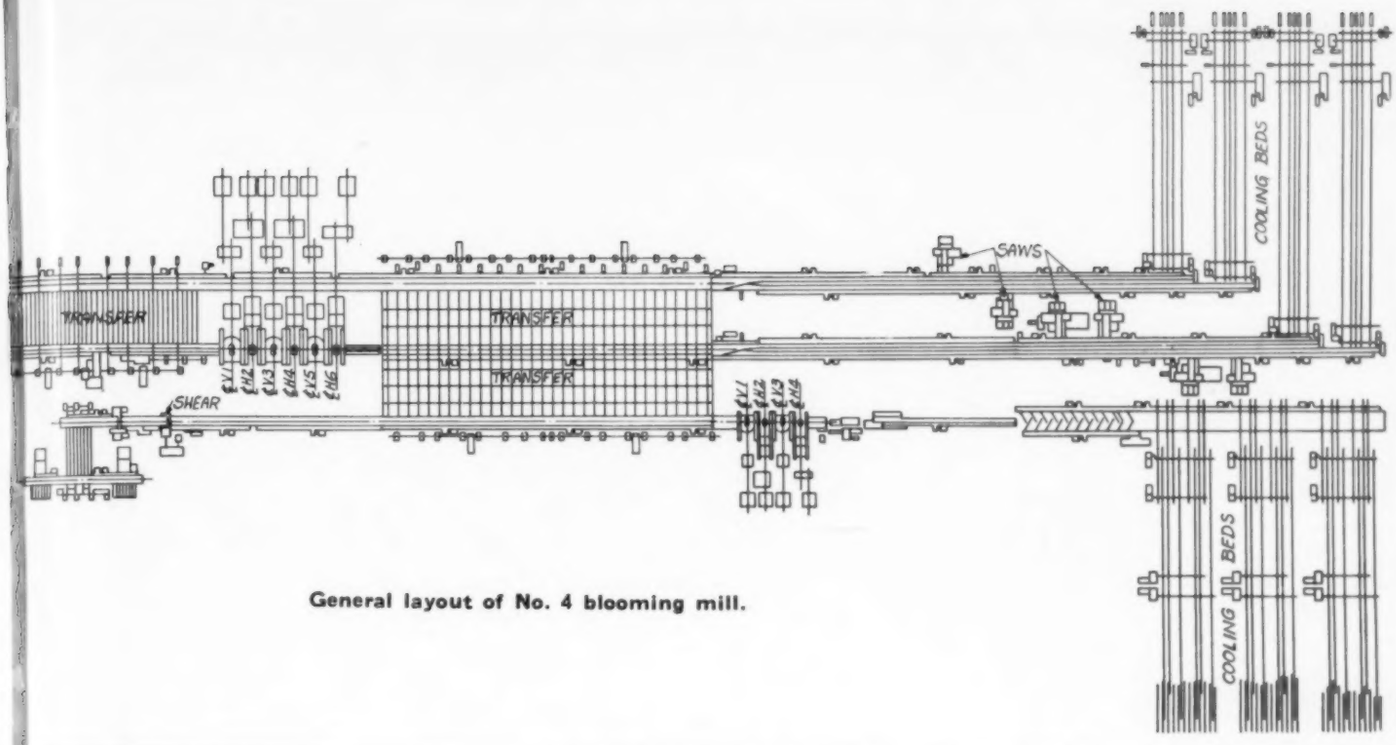
The 46-in. blooming mill is driven at speeds up to 800 fpm by a twin drive consisting of two 4000-hp, 40-80 rpm, 800-v, d-c reversing motors.



such as to offer fast guide changing. No feed rollers are installed on this mill, as blooms are of sufficient length to enter properly from the action of the mill tables. Front and back mill tables are driven by four 75-hp motors.

The 38-in. mill is driven through 30-degree double helical pinions, of 38-in. pitch diameter, 54-in. face and 28 teeth, by a 5000-hp, 65-130-rpm, 700-volt d-c shunt motor, giving a maximum mill delivery speed of 1360 fpm. Power is supplied to this drive from a motor-generator set consisting of two 2000-kw, 700-volt d-c generators and a 5000-hp, 508-rpm, 13,800-volt induc-

This 38-in. bar mill is essentially a second blooming mill. It is, however, equipped with guide box assembly on each side, making possible the precision rolling of rounds.



General layout of No. 4 blooming mill.

tion motor. An exciter set and a rotating regulator set complete the variable voltage control of this reversing drive.

Variable voltage control is also applied to the front and back mill tables, screwdown, and sideguards of this mill, with power coming from two motor-generator sets each consisting of six 150-kw and one 60-kw generators, all of 250 volts, driven by a 900-hp, 1200-rpm, 2300-volt synchronous motor.

Rounds leaving the 38-in. mill are conveyed over either of two tables, each containing a 60-in. hot saw driven by a 300-hp motor at a blade speed of 18,240 fpm. They then pass on to chain conveyor cooling beds and drop into cradles. The rounds are then moved by overhead crane to a conditioning area.

Blooms for further rolling leave the 38-in. mill, 9 in. × 8 in. in size, pass through a hot scarfing machine mounted over the mill table, and continue over a transfer to the parallel mill line which leads to the six-stand billet mill. A 60-in. hot saw is installed ahead of this mill to crop and divide the bloom. Also, the hot scarfing machine previously mentioned may be moved over to this table when the 38-in. mill is by-passed. The six-stand billet mill consists of three 30-in. vertical roll stands and three 28-in. horizontal roll stands, spaced alternately on 10 ft centers. Each stand is individually driven through gearing by a 1750-hp, 300-600-rpm, 600-volt d-c shunt motor. Gear ratios are such as to give mill speeds as follows:

Stand No.	Motor rpm	Gear ratio	Roll rpm	Billet speed, fpm
1	300-600	15.4	19.48-38.96	153-306
2	300-600	12.01	24.98-49.96	183.5-367
3	300-600	11.56	26.0 -52.0	206-412
4	300-600	9.32	32.2 -64.4	236-472
5	300-600	8.86	33.8 -67.6	266-532
6	300-600	6.357	47.1 -94.2	346-692

The six drive motors receive power from a motor-generator set made up of four 2000-kw, 600-volt d-c generators driven at 514 rpm by an 11,200-hp, 13800-volt synchronous motor.

The rolls, which have a body length of 48 in., run in roller bearings. Pinion bearings are roller type for the vertical stands (No. 1, 3 and 5) and babbitted for the horizontal stands (No. 2, 4 and 6). Gear reduction sets are completely equipped with roller bearings.

In each stand, the rolls are adjusted through the action of 9-in. mill screws of ½ in. pitch, driven by a 7.5-hp, 230-volt d-c mill type motor. In the horizontal roll stands, the top roll is hydraulically balanced. In the vertical roll stands, one roll is held against the housing seat by hydraulic pressure, while the other roll is hydraulically balanced against the mill screws.

The vertical roll stands are very much like horizontal roll stands laid over on their sides, and are capable of taking the same draft as the horizontal stands. Their housings are enclosed within outer housings which rest on the shoe plates, and contain another screw lift mechanism, driven by a 25-hp motor for pass alinement. Thus, the housing containing the vertical rolls can itself be raised and lowered a total travel of 36 in., so that vertical roll passes can be alined with the horizontal roll passes. This movement can be made without disconnecting the mill from its drive.

Vertical rolls are driven from the motor and main gear reduction set through a horizontal shaft to an intermediate bevel gear set, through an inclined shaft to a combination bevel gear set and pinion stand. The intermediate sets contain spiral bevel gearing with a pinion of 40.744 in. pitch diameter and a gear of 66.208 in. pitch diameter. The angle of mesh is 50 degrees and the gear face 21 in. The second bevel sets have pitch diameters of 38.77 in. and 84.464 in. respectively, for pinion and gear. The angle of mesh in these sets is 40 degrees, and the gear face 24 in. The mill pinions in this

This six-stand billet mill consists of alternate vertical and horizontal roll stands on 10-ft centers. The unusual drive and mounting arrangements of these stands afford a high degree of operating flexibility.

combination drive are single helical, with 30-in. pitch diameter 42-in. face and 22 teeth.

The horizontal rolls are driven from the motor and main gear reduction set through double helical 27-tooth pinions of 27-in. pitch diameter, 40-in. face. Each stand, with its pinion stand and spindle carrier, is mounted as a unit so as to slide endwise on its bed plate for a distance of 42 in., operated by a 14-in. cylinder actuated by 1250-psi hydraulic pressure. Thus, these stands may be moved to aline horizontal roll passes with the vertical roll passes. Hydraulic clamps hold the housing to the bed plate at the desired point.

At the exit of the six-stand mill is a transfer capable of handling lengths up to 160 ft connected on one side to the runout table from the 38-in. mill previously described and on the other side to another parallel mill line leading to a four-stand billet train. Steel leaving the six-stand train may be delivered directly from the runout table to two saw lines containing stationary and movable 60-in. hot saws, and on to chain conveyor cooling beds, or it may be moved to the saw lines in the 38-in. mill line, previously mentioned. Skelp billets may be transferred to the mill line on the other side of the six-stand mill and taken in the reverse direction to a shear and cradle.

For still further reductions, billets leave the six-stand train, 4½-in. square and 50-150 ft in length and are moved over the transfer just mentioned to the mill line which contains the four-stand mill. This unit consists of four 20-in. stands, two with vertical rolls and two with horizontal rolls, placed alternately on 8 ft 6 in. centers. These stands are similar in design to those in the six-stand mill. Each stand contains rolls, 20 in. in diameter, and is driven individually by a 1250-hp, 400-800-rpm, 600-volt d-c shunt motor, with gear ratios and speeds as follows:

Stand No.	Motor rpm	Gear ratio	Roll rpm	Billet speed, fpm
1	400-800	7.775	51.5-103	270-540
2	400-800	6.3	63.5-127	333-666
3	400-800	4.62	71 -142	372-744
4	400-800	4.867	82 -164	430-860

A motor-generator set composed of two 2000-kw, 600-volt d-c generators driven by a 5600-hp, 514-rpm, 13,800-volt synchronous motor supplies power to these drives.

Bearing application is similar to the six-stand mill, with roller bearings on all roll necks, all gear sets, and

on the pinions of the vertical roll stands (No. 2 and 4).

Mill screws are 7 in. in diameter with ½ in. pitch, and are driven by one 7.5-hp, 230-volt d-c motor on each stand. As in the six-stand mill, the vertical roll stands are movable in a vertical direction under the action of 25-hp motors for pass alinement, and the horizontal roll stands may be moved by hydraulic power in a horizontal direction for the same purpose.

Power is transmitted to the vertical rolls through a reduction gear set, an intermediate bevel gear drive, and a combination bevel gear drive and pinion stand, as previously described for the six-stand train.

Billets leaving the four-stand mill pass on to a steam-operated flying shear located 16 ft 8 in. beyond the last mill stand, and over three cooling beds to a storage area.

Lubrication of the entire No. 4 blooming mill unit is carried out by automatic systems wherever possible. On the 46-in. mill equipment, there are five circulating oil systems that serve 142 bearings, and 11 grease systems (five automatic and six manual) supplying 675 bearings. The 38-in. mill has five circulating oil systems and ten grease systems. Three circulating oil systems and one grease system serve the six-stand mill, while the four-stand mill has two circulating oil systems and one grease system. The finishing end has 20 grease systems (seven automatic and 13 manual) serving 3260 points on tables, cooling beds and auxiliary equipment.

Mill scale falling through the mill tables is washed down a system of sluiceways to scale pits, where it settles out and is periodically removed by clamshell bucket and loaded into railroad cars for use in the blast furnaces.

Main drives for the 46-in., 40-in., and six-stand mills are located in a motor room paralleling the mill. Here also are the motor-generator sets for the drives and controls for the mills, as well as the necessary switchgear. Rotating units are cooled by air drawn from the motor room down through the units into the basement where it is cooled and returned to the motor room. This is a closed circulating system, with make-up air from the outdoors being cleaned by electrical precipitators.

The drive-motors of the four-stand mill are located in the mill building, but are ventilated by air through ducts from the ventilating system of the main motor room.

Normal rolling practice calls for ingots 31 in. × 31 in. or 32 in. × 32 in., in weights averaging 18,000-20,000 lb, to be reduced to 15 in. × 15 in. blooms in 17 passes in the 46-in. bloomer, and delivered to the 38-in. bar mill, where it is further reduced to 9 in. × 8 in. blooms in nine passes or to large rounds of 8¼-12¼ in. diameter.

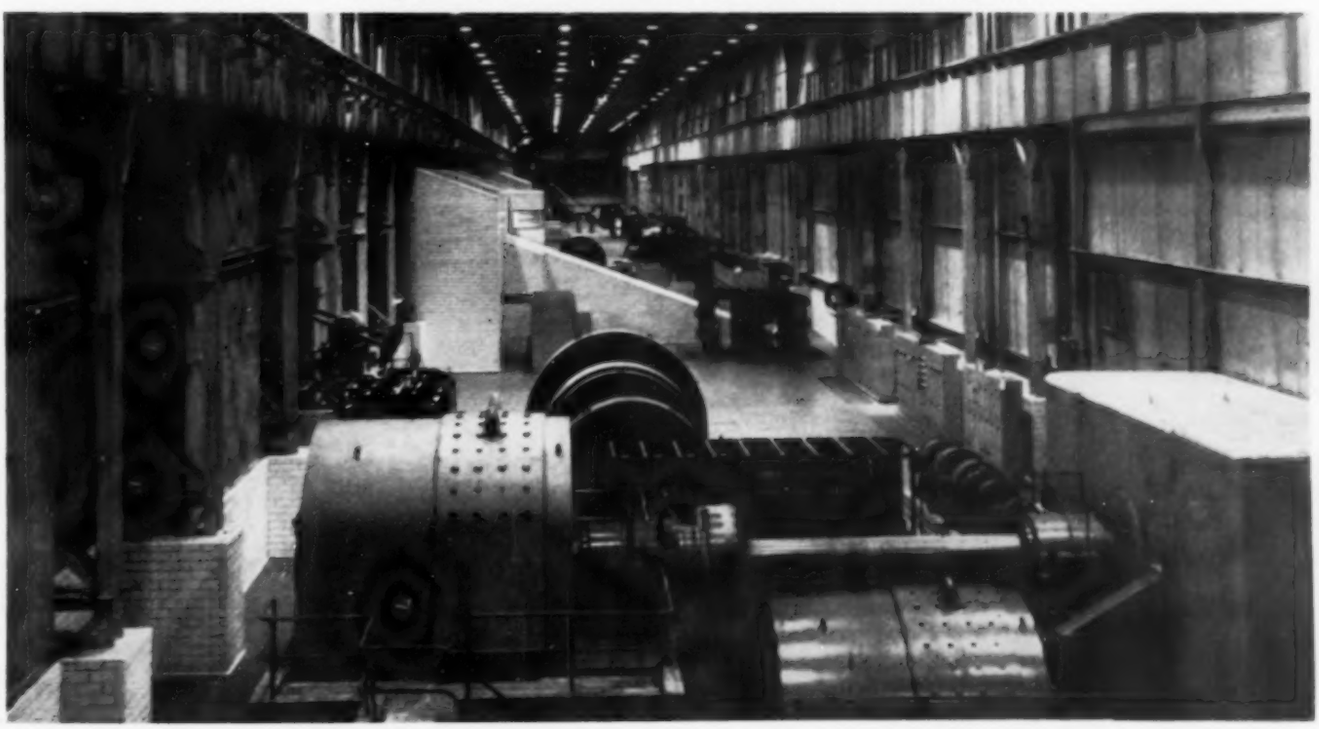
Smaller sizes are produced by putting the 9 in. × 8 in. blooms from the 38-in. mill (or if necessary or desired, direct from the 46-in. mill) through the six-stand billet mill. This unit produces tube rounds 4¾-5½ in. in diameter or rectangular sections 4 in. thick and 4-9 in. wide, or up to 12 in. wide if supplied with 12 or 14-in. slabs.

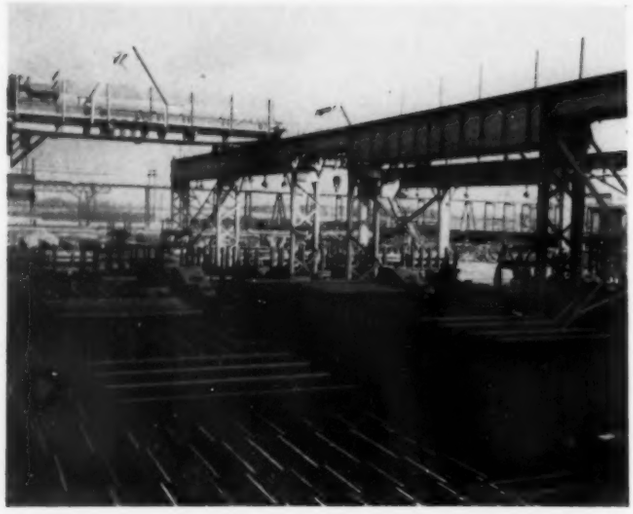
For still smaller sizes, billets 4½ in. × 4½ in. from the six-stand billet mill are transferred to the four-stand billet mill, which reduces them to 2½-4 in. squares or 3¼-3¾ in. rounds.

Due to the flexibility of its arrangement, this mill combination can actually roll two or three different sizes at the same time.

Additional blooming mill capacity is provided by an older unit, a 40-in. blooming mill followed by a 32-in. bar mill. Ingots are heated for this unit in five blocks of regenerative soaking pits, of four holes each. Each pit is 10 ft 6 in. long × 6 ft wide × 7 ft 11 in. deep. Coke oven gas is used as fuel, entering through three

The No. 4 mill motor room is ventilated by a closed circulating system, with fans and surface type air coolers in the basement. In the foreground is the twin motor drive of the 46-in. blooming mill.





Rounds from the new No. 4 mill unit pass over these hot beds before being taken to the conditioning department.

nozzles at the bottom of the air port. All control is manual. Ingot heating time ranges from three hours upward, depending on the temperature of the steel charged into the pits.

Ingots are handled into and out of the pits by two 15-ton pit cranes, and a buggy conveys the ingots to the mill approach table.

In the 40-in. mill, rolls 38½ in. in diameter × 96 in. body length run in babbitted bearings, driven by a 5000-hp, 0-120-rpm, 600-volt d-c reversing motor of 1,500,000 ft-lb maximum torque. Power is supplied to this motor from a motor-generator set consisting of two 2200-kw, 600-volt d-c generators driven at 368 rpm by a 3000-hp, 6600-volt induction motor, with a 120,000 lb flywheel. The mill has a maximum delivery speed of 1100 fpm and rolls an average of 98.5 tons per hr, producing blooms from 7 in. × 9 in. to 13½ in. × 12½ in. and slabs 9 in. × 3½ in. to 12⅜ in. × 3½ in. The product consists of about 90 per cent blooms and 10 per cent slabs.

Mill screws, 12 in. in diameter with 2 in. pitch, are operated at a maximum lifting speed of 16 fpm by two 100-hp mill type motors under constant voltage magnetic control. Roll balance is hydraulic. Side guards are driven through rack and pinion by four 75-hp mill motors, also under constant voltage control.

Located 149 ft 3 in. beyond this mill is a shear capable of cutting sections up to 14 in. square, with a gage for lengths of 30-192 in. Crops are transferred by chain conveyor to railroad cars outside the building.

In line with the 40-in. mill and 301 ft 3 in. beyond is a single stand, two-high 32-in., reversing bar mill, driven by a 3000-hp, 65-130-rpm, 650-volt d-c motor. This mill employs rolls 36 in. in diameter × 72 in. body length, with babbitted roll neck bearings. Roll settings are effected by manually operated screws of 8 in. diameter, 1 in. pitch. On each side of the mill are conventional built-up guides and strippers mounted on the mill housing. The housing and guides are changed as a unit.

The 32-in. mill receives blooms ranging from 9 in. × 7 in. to 13⅝ in. × 13¾ in., weighing 4336-14,500 lb, and produces billets up to 6 in. square, skelp slabs up to 6⅝ in. × 3½ in., and rounds ranging 4$\frac{53}{64}$-12$\frac{29}{64}$ in. in diameter. Maximum mill delivery speed is 1206 fpm, and an average rolling rate of 90 tons per hr is maintained. Product from this mill proceeds on to hot saws and then to cooling racks in the bar yard.

Adjacent to the delivery ends of both blooming mills are conditioning areas equipped with three peeling machines for skinning round billets to remove surface defects, and with scarfing beds for blooms, billets and small rounds. Rounds larger than 5½ in. diameter are peeled.

SKELP MILLS

Butt welded pipe forms a considerable portion of the Lorain plant's production. Skelp for this operation is furnished from two mills, both originally installed about 45 years ago. No. 1 skelp mill consists of eleven 14-in. stands and two vertical edgers. Details of this mill are as follows:

Stand No.	Distance from preceding stand ft-in.	Roll diameter, in.	Roll rpm	Speed, fpm
1	.....	12⅞	59.7	201
2	9-0	13⅜	90.6	318
3	5-6	13⅜	137.5	481
4	20-0	12¾	92.2	308
5	5-6	12½	129.0	422
6	5-6	10⅛	180.0	472
7	40-1⅜	13¼	92.6	322
8	5-6	13¾	127.4	459
9	5-6	13½	178.1	623
Edger	9-0	15	184.7	725
10	60-0	13½	210.2	745
Edger	79-6	15	275.0	1080
11	8-6	15	278.5	1095

The first nine roll stands are driven through a rope drive and gearing by a 30 in. × 60 in. × 60 in., 72-rpm steam engine, while stands No. 10 and 11 are driven through rope drives by a 30 in. × 60 in. × 42 in., 131-rpm steam engine. The vertical edgers are motor driven. A dividing shear is placed between stands No. 6 and 7.

The mill receives slabs 4 in. thick in widths of 4-11⅞ in. and in weights of 210-976 lb, and produces skelp ranging from 4⅜ in. × 0.18 in. to 12 in. × 0.173 in. Slabs are heated in two 34 ft 11½ in. × 11 ft 6 in. continuous pusher furnaces, fired with coke oven or natural gas under manual control, and served by an overhead crane which deposits slabs upon the furnace pusher table.

Product from No. 1 mill proceeds to a double hot bed 128 ft long × 9 ft 5 in. wide, in the runout tables of which are two ¾ in. × 6 in. clipping shears and two 1 in. × 12 in. shears. The cold bed is 8 ft wide × 40 ft long. In the clipping shears, the corners are cut off one end of the strip and the pointed end is cupped and bent slightly upward to assist in subsequent entry into the welding bell on the butt mills.

No. 5 mill contains 13 two-high, 13-in. stands and one vertical edger, with characteristics as follows:

Stand No.	Distance from preceding stand ft-in.	Roll diameter, in.	Roll rpm	Speed, fpm
1	.....	15	40.95	162
2	9-0	15 3/4	40.95	169
3	19-6	15	40.95	162
4	6-0	15 5/16	60.45	242
5	5-6	12 3/8	91.0	295
6	46-0	14 1/4	58.5	218
7	5-6	14	91.0	334
8	15-0	15	39.95	157
9	5-6	15 1/2	62.4	255
10	5-6	15 1/2	97.5	396
Edger	5-6	.....	89.1	.....
11	45-0	14 3/4	152.2	589
12	15-0	13 3/4	237.82	856
13	15-0	14 3/4	339.52	1320

The first ten stands of this mill are driven through a rope drive and gearing by one 2500-hp, 187.5-rpm, 6600-volt a-c motor. A duplicate motor drives stands No. 11, 12 and 13 through rope drives. The edger is driven by a 50-hp, 525-rpm, 220-volt d-c motor.

No. 5 mill produces skelp from 2 3/4 in. wide × 0.098-0.103 in. thick to 5 11/16 in. wide × 0.127 in. thick.

Heating facilities consist of two continuous pusher type furnaces, 42 ft long, one of them 8 ft wide, the other 13 ft wide. These furnaces are also fired with coke oven or natural gas under manual control. Slabs are placed on the pusher table by an overhead crane.

A dividing shear designed for 1 1/4 in. × 4 in. hot steel is located between stands No. 5 and 6. The mill is served by a double hot bed 128 ft long × 10 ft wide, with two 3/4 in. × 6 in. clipping shears and two 3/4 in. × 6 in. cutoff shears. The cold bed for this mill is also 8 ft wide × 40 ft long.

BUTT WELD PIPE MILLS

Six butt mills produce butt welded pipe and tubing in single lengths with diameters ranging 1/2 to 1 in., and in double lengths of 1 to 3 in. diameter. Skelp comes to these mills in sizes from 0.104 in. × 2 3/4 in. × 19 ft 5 in. up to 0.210 in. × 12 in. × 39 ft 9 in.

One regenerative furnace is provided for each mill. Furnaces on the three single-length mills are 22 ft 1 1/2 in. × 8 ft 4 in., while those on the three double-length mills are 40 ft 10 in. × 8 ft 6 in. All are fired with coke oven gas or natural gas, with automatic control on gas-air ratio and furnace temperature. Gas and air is introduced through burner ports along the sides of the furnace. Skelp is charged lengthwise into the furnace by pusher, chain or magnetic roller type chargers so that the skelp, lying side by side, covers the hearth. Thus, each furnace holds from seven plates 12 in. wide to 23 plates 2 3/4 in. wide. Heating to a temperature of 2650 F requires only about three minutes. Fuel consumption averages 3,000,000 btu per ton. This heating operation is the critical point of the entire butt-weld operation.

When the skelp is heated, its shaped end, as formed by the clipping shears at the skelp mill, is grasped by tongs of special design, a welding bell is slipped over the tongs and hooked behind a stop, and the tongs are hooked into a traveling draw chain. Thus, the skelp is pulled through the welding bell and formed into a tube, while its edges are forced together with sufficient pressure to form a weld. Jets of oxygen impinging on the edges raise the temperature to insure welding heat.

The pipe is next transferred to a sizing mill, consisting of a single two-high stand with grooved rolls. The pipe then moves over a cooling transfer and, on five of the mills, doubles back through three more pairs of rolls (two horizontal, with a vertical pair between) for final sizing and scale removal. An overall reduction of 8-12 per cent on the diameter of the pipe, which is drawn slightly oversize, is effected in the four pairs of rolls.

The sixth mill is equipped with an eight-stand stretch reducing mill which is the unit upon which experimental work was done in developing this method of tube reduction. The method will be subsequently discussed in more detail in connection with the new seamless tube mill.

In all of the mills, the pipe then passes over a second cooling transfer to a saw, where it is cut to the desired lengths. A water dip serves to wash out loose scale. In the finishing departments of these mills the pipe is

Six butt mills produce butt welded pipe in sizes from 1/8 in. to 3 in. This view shows a length of skelp being pulled from the heating furnace through the welding bell.

After passing through a pair of sizing rolls and over a cooling bed, butt welded pipe passes through three pairs of rolls (two horizontal with a vertical pair between) for final sizing and scale removal.

cut, threaded, oiled, stenciled and prepared for shipment.

Pipe may be galvanized in a hot dip process, the pipe being given a caustic soda wash, pickled and rinsed, then immersed in a fluxing solution of zinc ammonium chloride and then in the molten zinc bath. A hot water dip sets the galvanized coating.

SEAMLESS MILLS

Tube making facilities of the Lorain plant have recently been expanded by the installation of No. 4 seamless mill. The product includes standard pipe, line pipe, oil well tubing and boiler tubes. The operation of the mill is almost entirely automatic. Regardless of the pipe size being made, this mill uses only 5½ in. diameter round billets.

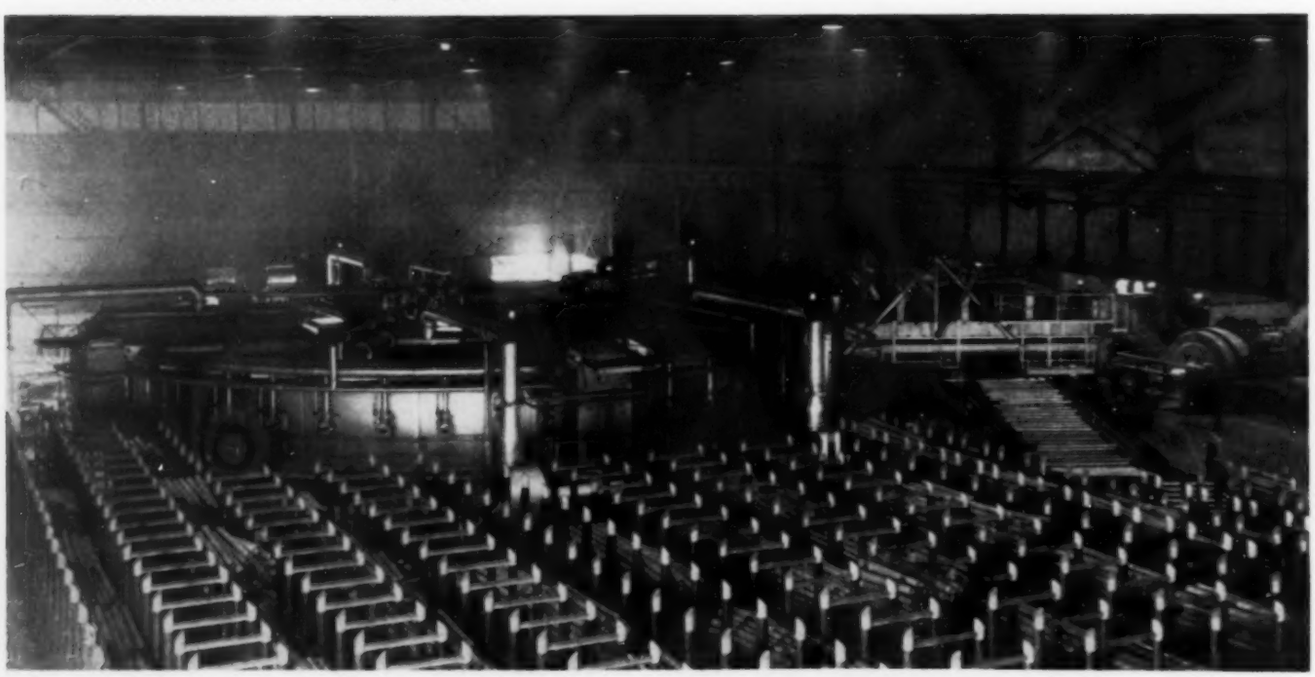
The rounds 3-16 ft in length, are heated in a rotary hearth furnace about 84 ft overall diameter. The doughnut-shaped hearth, which rotates on wheels independent of furnace side walls and roof, has a 78 ft outer diameter and a 42 ft inner diameter, giving a usable hearth width of 16 ft. The furnace is fired with coke oven gas and is divided into five heating zones, each equipped with automatic temperature control. Heating time for the 5½ in. billets is approximately 1 hr 22 min, and the rated capacity of the furnace is 75 tons per hr.

Billets from an adjacent storage area are placed by overhead crane upon a transfer conveyor which feeds a charging machine. This machine automatically grips the billets, carries it forward and places it on the hearth. After making an almost complete revolution, the rotating hearth has carried the billet from a position in front of the charging door to a position in front of the discharge door. The angular space between the charging and discharging doors is approximately 13 degrees. A discharging machine similar to the charging machine removes the heated billet from the furnace and places it on a conveyor which carries it to the inlet table of the piercing mill. The rollers of this conveyor are skewed, causing the billet to rotate and thereby removing scale as the billet travels from the furnace to the piercing mill. On the inlet table of the piercer, the billet is centered before it rolls into the inlet trough.

The piercing mill is a heavily designed unit driven by a 4500-hp, 225-rpm, 13,800-volt synchronous motor, through a reduction gear having a ratio of 2.25:1. The barrel-shaped piercer rolls, which are low carbon steel castings, are 24 in. long and 42 in. in diameter, and are held at a fixed feed angle of 10 degrees. The piercer, with a roll surface velocity of approximately 1110 fpm, delivers the pierced billet, 5¾ in. outside diameter, at speeds as high as 36 in. per second, indicating a high feed efficiency.

After the heated billet arrives at the piercer inlet trough, it is advanced by a pneumatic pusher until the centered end is gripped between the converging surface of the inclined rolls. The motion imparted to the billet by the rolls is one of rotation and axial advance. The two rolls, by exerting pressure only on the surface of the billet, are able to draw the metal over the mandrel to form a tube from a solid round bar. It is to be noted that the mandrel is not forced through the metal, but that the rolls cause the metal to flow over and about the mandrel. The piercer point is held in position on the end of a water-cooled mandrel support bar located on the delivery side of the mill. The opposite end of this bar is mounted in a thrust bearing which is carried in a traveling carriage that is latched stationary during the piercing operation. During the piercing operation, both the mandrel bar and the shell are closely guided to insure uniform wall thickness in the shell. When the rear end of the billet has rolled clear of the piercer point, the thrust bearing carriage is unlatched and the mandrel bar is withdrawn from the shell, after which the hollow shell is ejected from the piercer outlet trough and rolls

Rounds for the new No. 4 seamless mill are heated in this rotary hearth furnace, which uses coke oven gas. The furnace is rated at 75 tons per hour.



to a positioning conveyor which advances it until the forward end arrives at a fixed distance from the entry side of the mandrel mill. The shell is then transferred to the shell inserter conveyor, where it remains until a lubricated cylindrical mandrel bar approximately 63 ft long is auto natically inserted through the shell, preparatory to rolling. The diameter of this mandrel may be 3.6 to 4.5 in. depending on the desired wall in the final product.

The mandrel mill is a continuous train of nine stands spaced on 44-in. centers. Each stand houses a pair of grooved rolls, 26 in. in diameter with a 9-in. face, operating in roller bearings. The stands are mounted 45 degrees from the vertical, successively in opposite directions, so that the roll shafts in adjacent stands are at 90 degrees to each other. These stands are individually powered by d-c motors having an aggregate rated capacity of 8500 hp. Power for these motors is supplied by a motor-generator set consisting of two 3000-kw, 750-volt d-c generators driven by an 8400-hp, 360-rpm, 13,800-volt synchronous motor.

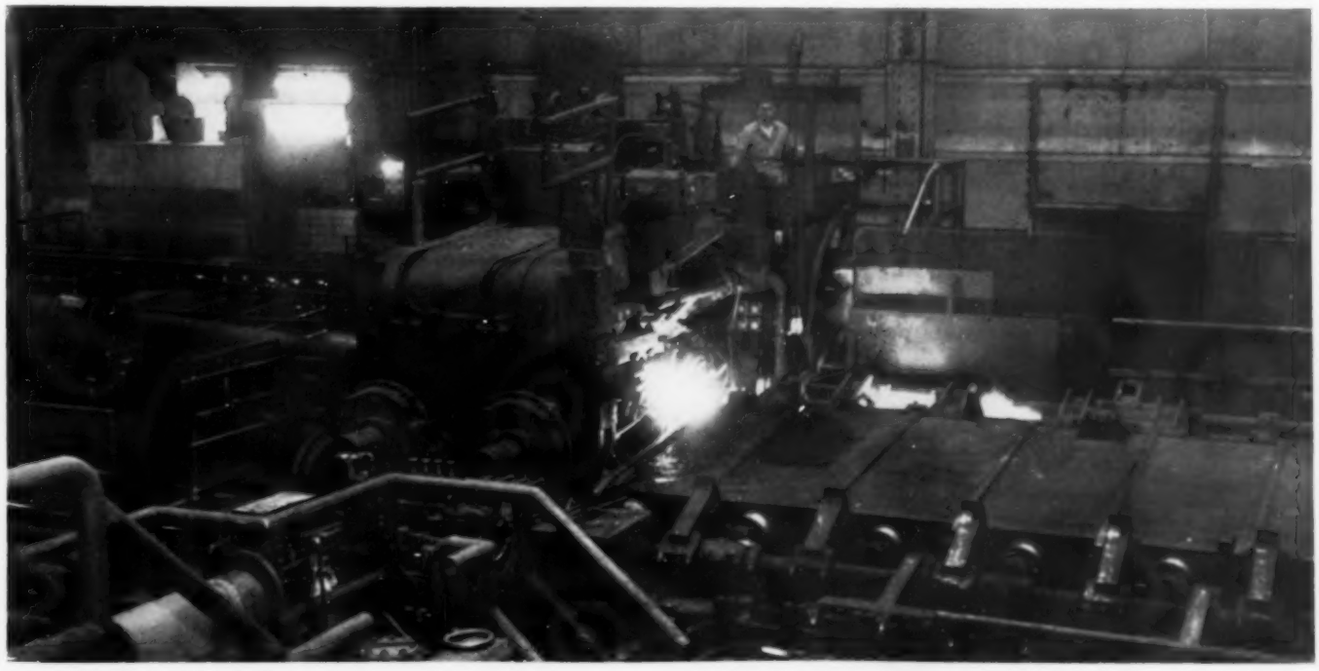
In rolling the shell on the mandrel bar in this mill, the first two stands reduce the diameter of the billet to bring the inside surface into contact with the mandrel bar. The next two are working stands in which the wall thickness is reduced considerably. The fifth and sixth stands perform similarly but effect somewhat less reduction in wall thickness, while the seventh and eighth are planishing stands. The ninth stand rounds the shell from its oval shape to facilitate removal of the mandrel bar. Mill delivery speeds range from 363 to 1096 fpm. The rolled shells delivered by the mandrel mill are $4\frac{15}{16}$ in. in outside diameter, regardless of the diameter of the finished tube. The maximum length of these rolled shells is 65 ft.

This mandrel mill replaces the plug mill and reelers of a conventional seamless mill and tends to make No. 4 seamless mill a continuous unit. After the rolled shell leaves the mandrel mill, with the mandrel bar inside, it is transferred across skids to either of two chain strippers. The tables of these strippers are equipped with motor-driven rollers which carry the shell and mandrel backward until the rear end of the mandrel is gripped by one of the chain strippers which withdraws the mandrel from the shell. The mandrel is then returned by conveyors and transfer tables to the entry side of the mandrel mill. While enroute, the mandrels are cooled and lubricated in preparation for the next working cycle. As soon as the mandrel is withdrawn from the shell, the rolls in the stripper inlet table reverse and convey the shell to the charging side of the of the reheating furnace.

The side-charge, end-discharge reheating furnace has a hearth 22 ft 9 in. long × 70 ft wide, and is fired by coke oven gas. It is equipped with three zones of automatic temperature control and with automatic pressure control. As the shell is rolled across the hearth of the furnace by paddle chains on 6 ft centers, proper rolling temperature is restored. The discharge trough of the reheating furnace is equipped with reversible motor-driven conveyor rolls which permit the shell to be delivered north through the 12-stand sizing mill or south through the 12-stand reducing mill. Water sprays remove scale from the shell as it leaves the furnace to go to either mill.

The stretch reducing mill is made up of twelve individual driven two-high overhung roll stands spaced on $14\frac{1}{2}$ in. centers. The roll stands are 45 degrees with the vertical, successively in opposite directions, so that the roll shafts in adjacent stands are at right angles to each other. Each stand is driven by a 200-hp, 850-1700-rpm, 600-volt shunt motor, for which power is furnished by a 2000-kw, 600-volt d-c generator driven by a 2800-hp, 514-rpm, 13,800-volt synchronous motor. The mill is equipped with cast alloy iron grooved rolls 13.97 in. in diameter with a 7-in. face. Roll shafts are

The piercer of No. 4 seamless mill is driven by a 4500-hp synchronous motor. Heated billets coming to the piercer are $5\frac{1}{2}$ in. in diameter for all tube sizes produced by the mill.



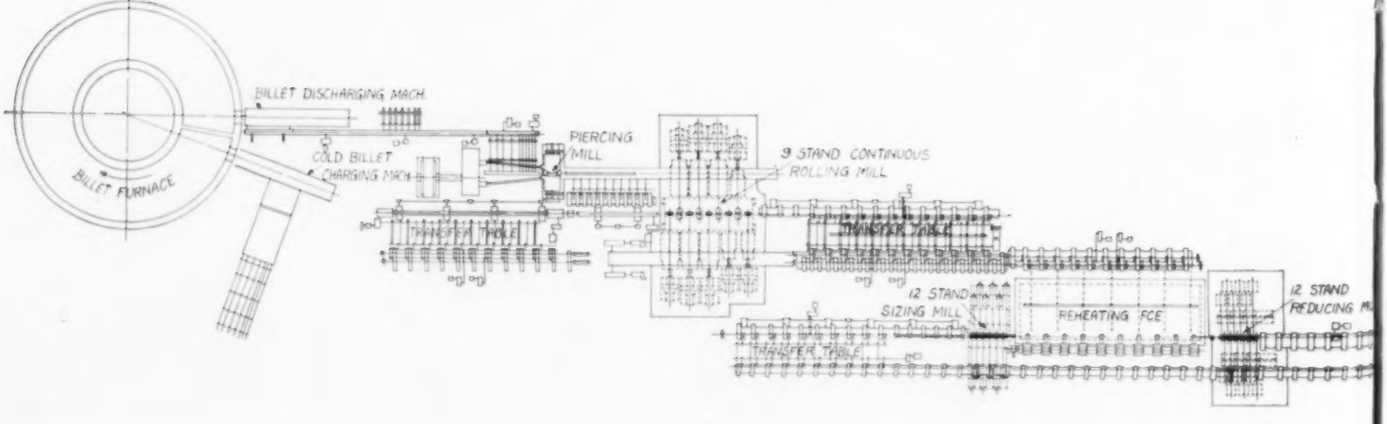
General view of No. 4 seamless mill, looking back toward the piercer and heating furnace. In the fore-ground is the continuous mandrel rolling mill, which replaces the more conventional plug mill.

mounted in roller bearings. The position of the bottom roll in these stands is fixed, and manual adjustment is provided for the top roll. Delivery speed of the mill ranges from 725 to 1450 fpm.

The tension or stretch reducing mill is a National Tube Co. development perfected in two previous installations. In this mill, while the diameter of the shell is being reduced, the wall thickness may be held constant or reduced as desired. Tension between the stands is set up by adjusting speeds of successive stands slightly higher than the delivery speed of the preceding stand. Diameter reductions of 10 to 12 per cent per stand are possible, as compared to 2 to 3 per cent in the conventional sizing mill. Reduction in wall thickness may range up to 20 per cent. Because wall thickness can be controlled in the stretch reducing mill, the process permits the use of a single diameter shell for a wide range of product sizes. The smaller pipe sizes which are produced in the stretch reducing mill have a maximum length of 142 ft.

The sizing mill consists of twelve overhung roll stands on 14½ in. centers mounted 45 degrees from the vertical as in the stretch reducing mill. The grooved alloy iron rolls of this mill are 13.97 in. in diameter with a 7-in. face. The roll shafts operate in roller bearings with the position of the bottom shaft being fixed and the position of the top shaft manually adjustable. Each stand is individually driven by a 75-hp, 850-1700-rpm shunt motor, with power provided by the same motor-generator set that serves the stretch reducing mill. The

General layout of No. 4 seamless tube mill.

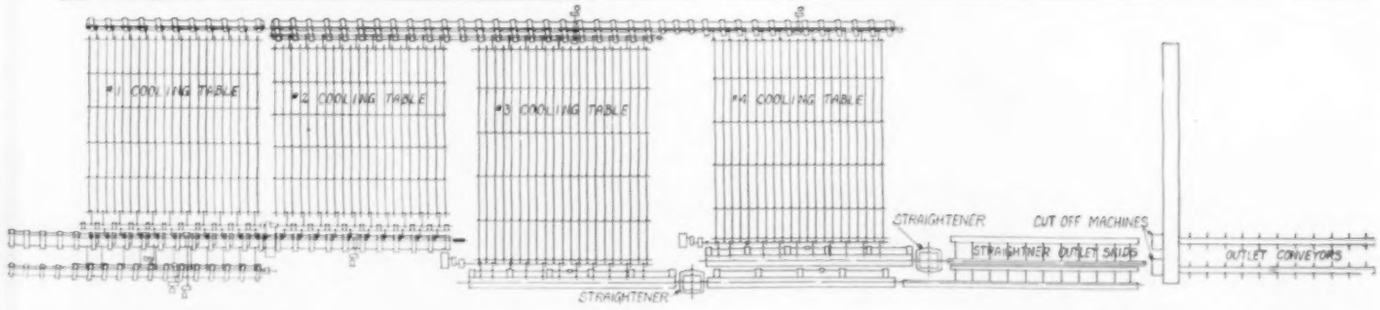


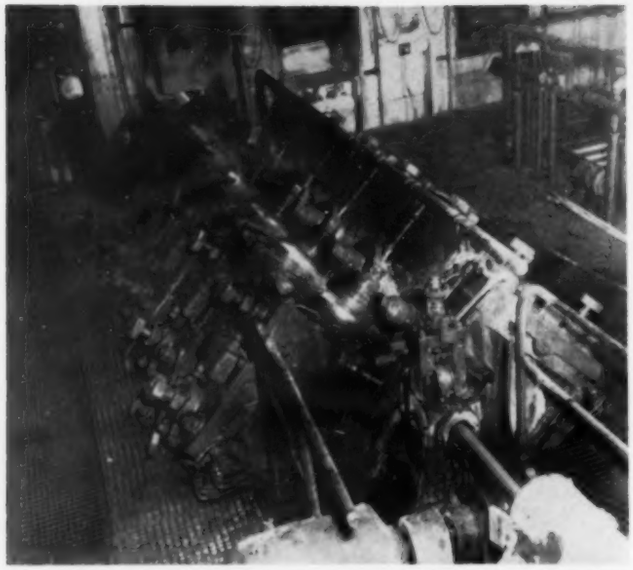
Leaving the mandrel mill, the shell is put through reheating furnace shown here, and then passes through either the sizing mill or the stretch reducing mill. This view is from the sizing mill end.

reduction ratio in the drives for the sizing mill is the same for all stands, giving a roll speed of 124-249 rpm and a delivery speed of 455-910 fpm.

Leaving either the stretch reducing mill or the sizing mill, tubes proceed over roller conveyors to two pairs of chain transfer cooling beds 70 ft wide × 63-79 ft long. These beds, which have a maximum rate of travel of about 10 fpm, are so arranged that the product from either mill will pass over two beds in series. In the discharge end of the cooling beds, the tubes roll to the parallel inlet conveyors of two three-roll straighteners. From the straightener runout tables, tubes are ejected to skids on which they roll by gravity to the charging device of the dual head rotary disc cutting-off machines, which automatically remove the crop and cut the tubes to length. The crop ends fall upon a belt conveyor which carries them to a scrap box.

In the south end of the mill building are three finishing and inspection lines, all capable of handling 2-4 in. pipe sizes. Two of these lines are equipped with dual head machines for automatically facing, chamfering, threading, screwing-on couplings and hydrostatically testing lengths up to 50 ft. The third line, which is equipped only with dual head automatic facing and chamfering machines and hydrostatic testing machine, will accommodate lengths to 65 ft.





Closeup of the stretch reducing mill, with reheating furnace in the background. Tension reduction is a National Tube Co. development, and permits the use of a single shell size for a wide range of product sizes.

Conveyor tables throughout the finishing end of the mill have case-hardened cast steel rollers running in antifriction bearings. While some of these conveyors operate at constant speed, others are designed with adjustable voltage control for variable speed, slow-down and stop operations.

Three older mills complete the seamless tube-making facilities of the Lorain plant. The first of these, No. 1 seamless mill installed in 1926, is a conventional single piercing unit with a plug mill, two reelers and 12-stand sizing mill. This mill produces tubes 2½ in. to 4½ in. outside diameter from billets 3¼-4¾ in. in diameter. The billets are heated in an end-charge, side-discharge roll-down furnace 14 ft wide × 48 ft long. Between the reelers and the sizing mill, a reheating furnace 33 ft 7 in. long × 5 ft 6 in. wide is provided. After the plug rolled shells have been reeled, they are reheated before being delivered to the sizing mill.

No. 2 seamless mill, installed in 1928, produces tubes 4½ in. to 12¾ in. in diameter from round billets which may range from 4¾ in. to 10 in. in diameter. Three 18 ft × 70 ft end-charge, side-discharge roll-down furnaces comprise the billet heating facilities. When the smaller diameter billets are being processed, only two of these furnaces are required. The mill is equipped with two piercers, a plug mill, two reelers, and two separate two-high sizing roll stands. Transfers are so arranged that the first piercing unit may be by-passed if desired.

No. 3 seamless mill, installed in 1930, produces 8⅝ in. to 26 in. outside diameter tubes from billets 7½ in. to 13 in. in diameter. While four end-charge, side-discharge roll-down billet heating furnaces are provided, only three of these furnaces are required when the smaller diameter billets are being processed. The mill consists of two piercing mills, a plug mill, a rotary rolling mill, two reelers and one single stand of two-high sizing rolls followed by a three-stand two-high sizing mill. A 15 ft × 42 ft reheating furnace is provided between the second piercing unit and the plug mill, and a second reheating furnace 15 ft × 52 ft between the plug mill and the rotary rolling mill. A third reheating furnace of tunnel type construction, approximately 65 ft long, is provided between the reelers and the sizing units.

General view of the finishing end of No. 4 seamless mill. Two of the lines are equipped for facing, chamfering, threading, screwing on couplings and hydraulic testing. The third line is not equipped for threading or coupling mounting.

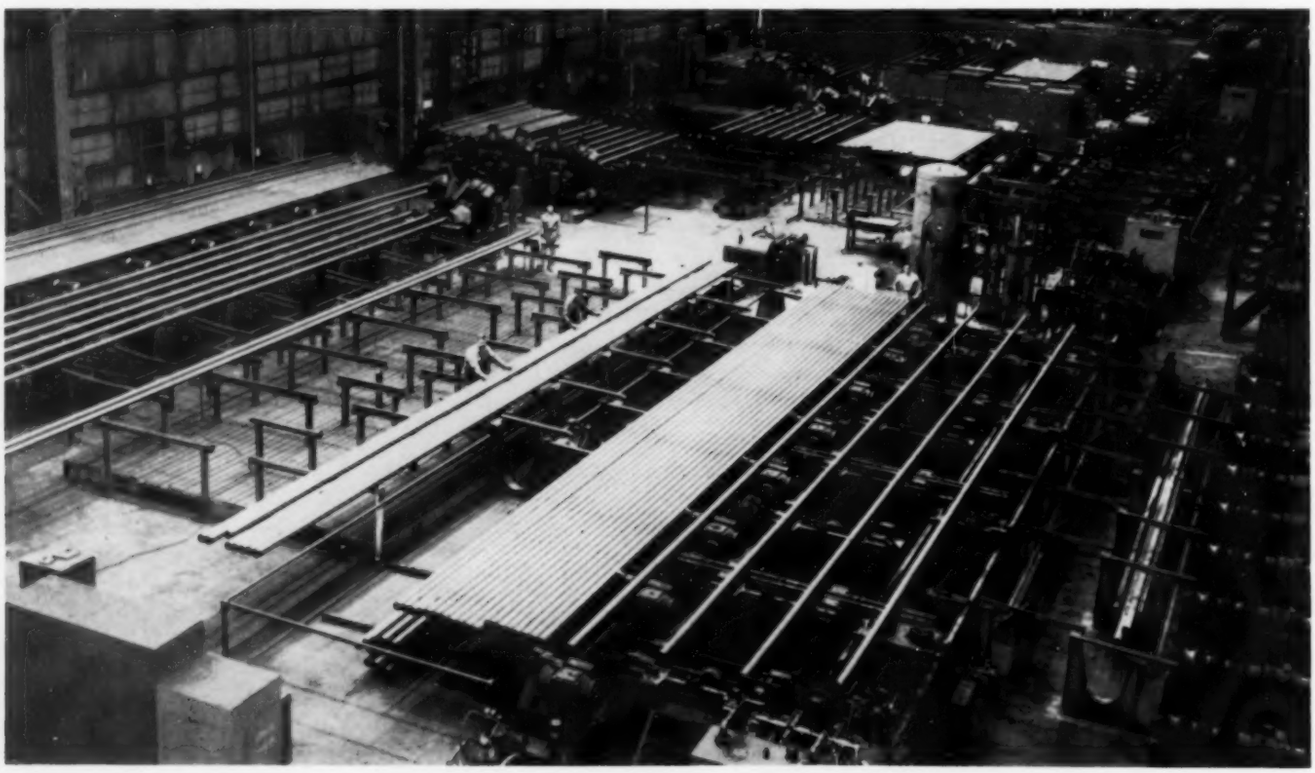


TABLE II

DRIVES FOR NO. 1, 2 AND 3 SEAMLESS MILLS

	Motor hp	Motor rpm	Motor voltage	Roll diameter, in.	Roll rpm
No. 1 Mill					
Piercer	1000	375	6600	29½-36	101.9
Plug mill	800	107	6600	20-22	107
Reeler (each)	300	350	230	22½-34 7/32	148.26
Sinking mill	300	300	230	.....	60
No. 2 mill					
No. 2 mill					
38-in. piercer	3000	250	6600	30 7/8-38	87.7
42-in. piercer	3000	250	6600	38-42	87.7
Plug mill	1500	62.5	6600	29-34	62.5
Reeler (each)	400	350	230	24-30	175
Sizing mill (each)	150	460	230	35-38	30.3
No. 3 mill					
42-in. piercer	3500	247	6600	35-42	77.1
46-in. piercer	3500	247	6600	42-46	77.1
Plug mill	2000	62.5	6600	32-36	62.5
Rotary mill	(2) 1500-1800	200-500	500-600	72-74	50-125
Breakdown sizer	350	360-450	230	35½-42	37.7-47.1
Reeler (each)	600	365	6600	33-36 3/8	91.25
Sizing mill No. 1	200	400	230	35½-42	30.25
Sizing mill No. 2	200	420-1050	230	35½-42	27.62-69.04
Sizing mill No. 3	200	420-1050	230	35½-42	27.5-68.8
Sizing mill No. 4	200	420-1050	230	37-42	33.14-82.85

Normally, when No. 3 seamless mill is producing tubes 14 in. and under, the rotary rolling mill is not employed. In the production of tubes 16 in. to 26 in., the plug-rolled shell is reheated and delivered to the rotary rolling mill, where the diameter of the shell is expanded and the wall thickness reduced to approximate finished dimensions. The action in a rotary rolling mill is similar to that in the second piercing mill except that disc type rolls are employed.

Data on the drives of No. 1, 2 and 3 seamless mills is set forth in Table II.

Overhead cranes remove the hot rolled product from cradles in the end of the cooling table on No. 1 and 2 seamless mills and place it in racks. After complete cooling in the racks, the material is straightened, inspected and cropped, after which it receives a second inspection before being given the final finishing operations. These final finishing operations are dependent upon the product being manufactured. After the final finishing operations, the tubes are hydrostatically tested, inspected, weighed, stenciled and, if required, coated before being loaded for shipment.

From the discharge end of the cooling table, the product from No. 3 seamless mill rolls directly to a six-roll rotary straightening machine from which it is delivered to the first inspection table. The inspected product is carried by overhead crane to the finishing floor where the crop is removed and the pipe given a second inspection, after which final finishing operations are performed.

A separate department provides the necessary facilities for cutting-off, facing, reaming, countersinking, recessing, tapping and electro-galvanizing couplings which are produced from seamless stock.

Facilities are provided at the delivery end of the three older seamless mills for direct shipment of finished seamless material produced in carload quantities, and about 60 per cent of the production from these mills is shipped from there. The remainder of the production, consisting of stock items or items which must be held for other products to complete the shipment, is sent to a storage yard approximately 1100 ft long × 81 ft wide, served by two gantry cranes. Stock in this yard may total 40,000 tons, involving 1800 stock items and perhaps 1200 operating order items.

A new warehouse, 1326 ft long × 125 ft wide and of unusual design, has been built across the delivery ends of the butt weld mills and the new No. 4 seamless mill. This warehouse is served by four overhead cranes, and can stock as much as 40,000 tons of tubular products, involving about 300 stock items in addition to items awaiting completion of the order for shipment. A total of 31 railroad cars can be spotted on the shipping tracks in this building. Loading operations are conducted on a production line basis to reduce crane movements.

The new warehouse serves as the loading area for direct shipments from No. 4 seamless mill, and for butt welded product. Material comes from these mills over narrow gage railroad.

SERVICES

The Lorain plant sets up a total electric demand of about 50,000 kw and consumes approximately 28,000,000 kwhr per month. This load is divided between a 60-cycle system serving the new installations and a 25-cycle system supplying the older parts of the plant.

The 60-cycle power is purchased from the utility company serving the district, with a monthly consumption of about 9,000,000 kwhr and a demand of 15,000

kw. The major portion of this power enters the plant at 132,000 volts and stepped down to 13,800 volts at the outdoor substation and then passes through 13,800 volt underground circuits which are connected to the plant system at substations located at the new No. 4 seamless tube mill, the new No. 4 blooming mill, and the new bessemer plant. Large units operate on 13,800 volts, and transformers supply 2300-volt and 440-volt power for smaller motors. Three 4160-volt circuits and one 2300-volt circuit also come into the plant through other transformer stations at various locations.

All 25-cycle power is generated at the blast furnace power house, and is distributed from the power house switchboard through four main circuits with main substations located at the coke plant, No. 3 blooming mill, No. 5 skelp mill, and two spots in the pipe mills.

Power generation equipment at the blast furnace power house includes four turbogenerators and five gas-engine driven generators, all generating 25-cycle power at 6600 volts. One steam unit, rated at 10,000 kw, is driven by a 15,000-hp turbine, another of 15,000 kw is driven by a 22,500-hp turbine, and two of 1500 kw are driven by 2250-hp low pressure turbines. All steam units operate at 1500 rpm, and are equipped with barometric condensers. Steam is provided at 250 psi, 120 degrees F superheat, except for the two low pressure units, which receive exhaust steam from the reciprocating blowing engines at 3-5 psi.

Gas engine units include two 2860-kw generators and three 3300-kw generators, all operating at 83.3 rpm. They operate on blast furnace gas, with a consumption of about 15,000 Btu per kwhr.

The 25-cycle generating equipment produces approximately 19,000,000 kwhr per month with a demand of 35,000 kw.

Steam for the turbogenerators, blast furnace blowers, pumps, miscellaneous processes and heating is produced at 250 psi, 550 F, in six 1260-hp vertical water tube boilers of 80,000 lb per hr capacity each and three 2500-hp, three-drum bent tube units, each of 118,000 lb per hr capacity. All of these units burn blast furnace gas with fuel oil as a standby, and the three large boilers are also equipped for pulverized coal.

Steam for the coke plant comes from six 509-hp, 190-psi boilers and three 1000-hp, 250-psi boilers, all equipped with chain grate stokers for burning coke breeze and with burners for coke oven gas.

The remainder of the steam requirements of the plant is supplied from the waste heat boilers at the open hearth, previously described.

Service water requirements of the Lorain plant total approximately 122,000,000 gal per day. This is originally pumped from the Black River through several pumping stations, all interconnected through the plant system. At the blast furnace are two 30,000,000 gal per day pumps taking water directly from the river through a suction tunnel. Along the river at various locations are three more pump houses containing a total of 14 pumps. Five of these, with a combined capacity of 124,000,000 gal per day, are high head units pumping directly into the system, while nine are low head pumps with a total capacity of 36,000,000 gal per day pumping from the river into two reservoirs on the plant property, principally over week-ends. These reservoirs also receive return water from condensers, blast furnaces, etc., and from various units in the rolling mill area.

Two additional houses pump water into the plant system from the two reservoirs. Each of these houses contain two 7,000,000 gal per day high head pumps.

Boiler feed water is taken from the river water system and put through a cold lime-soda softening plant consisting of nine settling tanks and four sand filter beds. Approximately 100,000,000 gal are softened per month.

Approximately 1,000,000 gal per day of water is purchased from the Lorain city water system for drinking and sanitary purposes, and for some other special uses.

Compressed air to the extent of about 23,000,000 cu ft per day is provided by 27 air compressors spotted around the plant at the principal consuming centers and having a total capacity of 30,000 cfm.

Natural gas is purchased from the gas company through two 10-in. lines. The gas enters at 60-psi pressure, passes through reducing stations and into the general plant system. It is used primarily when the coke oven gas supply is not sufficient to meet requirements. Consumption runs 13,000,000 cu ft per working day.

A full complement of shops fulfill all maintenance requirements of the plant.

This new warehouse, 1326 ft x 125 ft, is built across the delivery ends of the butt weld pipe mills and the new seamless mill.

Q. WHO'S McDOWELL?

A. MECHANICAL ERECTORS OF NATIONAL TUBE COMPANY'S NEW BLOOMING, BAR, BILLET AND SEAMLESS MILLS AT LORAIN, OHIO

. . . and many of the accessories to these new mills. McDowell is an organization of versatile inquisitive engineers, quick witted and freethinking, devoted to solving the heavy erection problems mill men customarily set aside for an expert . . . Why not drop around to see us while you're in Cleveland? But please don't look for ivy-clad walls here, because this is a young, dynamic can do kind of an outfit—building its reputation, and its friendships, with the McDowell Method—a complete engineering service for heavy industry. That service is available now, to you.

McDOWELL COMPANY, Inc.
CONTRACTORS AND ENGINEERS
3203 W. 71st STREET CLEVELAND 2, OHIO

R. C. McDOWELL
President

H. E. BANKS, vp
General Superintendent

W. N. YOUNG, vp
Chief Engineer

F. W. NIGGEMEYER
Sales Manager

Shown here is a 250-ton push-pull, screw-type Stripper crane, used for stripping both small end-up ingots, and large end-up ingots with hot tops. An added feature for faster handling is the retractable bull nose; with this, no adjustments are necessary when stripping ingots of various types and sizes. Alliance builds this Stripper crane in various capacities up to 800 tons, with a safety factor of 5. If your installation does not warrant a stripper of this kind, ask us about our impact stripper, which makes use of the most reliable of all forces, gravity. The Alliance Machine Company builds all types—all sizes—to move heavy loads safely, quickly, economically. Always rely on Alliance to give your plant dependable, extra lifting power.

BIG
CRANES

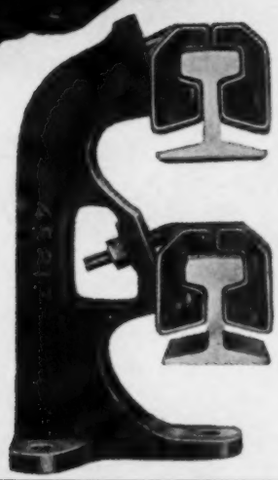
THE ALLIANCE MACHINE COMPANY

MAIN OFFICE
ALLIANCE, OHIO

PITTSBURGH OFFICE
1622 OLIVER BUILDING, PITTSBURGH, PA.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES
STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH
CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

POSITIVE POWER with PROVED PERFORMANCE



Typical Keystone Double Rail under-running installation, used to operate heavy cranes, conveyors and industrial haulage systems.

Assembly of No. 45813 Standard, No. 45815 Insulator and No. 45814 Clamping Bolts.

KEYSTONE PRODUCTS PROVIDE POSITIVE INSULATION AT NATIONAL TUBE

Installed by some of the nation's leading builders of steel mill equipment and made to meet special requirements, Keystone insulators and collectors are playing a vital part in the new National Tube plant at Lorain. In addition there are also many regular Keystone products in use throughout this modern steel producing organization.

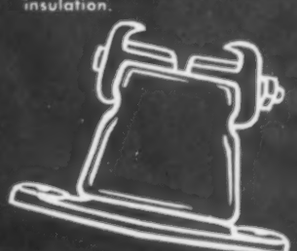
On heavy cranes, ore and coal bridges, unloading conveyors and other types of industrial haulage systems, this under-rail contact system has proved its outstanding value of positive power. The Keystone method of suspending the rail permits free expansion and contraction of conductor, thus preventing insulator breakage. The under contact system is a further protection against poor contact due to prevalence of dust, snow or sleet.

For lasting, positive transmission of power, specify Keystone. Write today for the catalog on industrial insulation systems.

Type DD Keystone Contact Rail Insulator for over-running service. Glazed semi-porcelain block insulator. Takes 30- to 100-lb standard rail sections.

Type BO Keystone Contact Rail Insulator for over-running service at 750 volts or less, where great mechanical strength is required.

Type PGB Keystone Contact Rail Insulator, for under-running service. Weather-proof porcelain insulator housing, compact mica insulation.

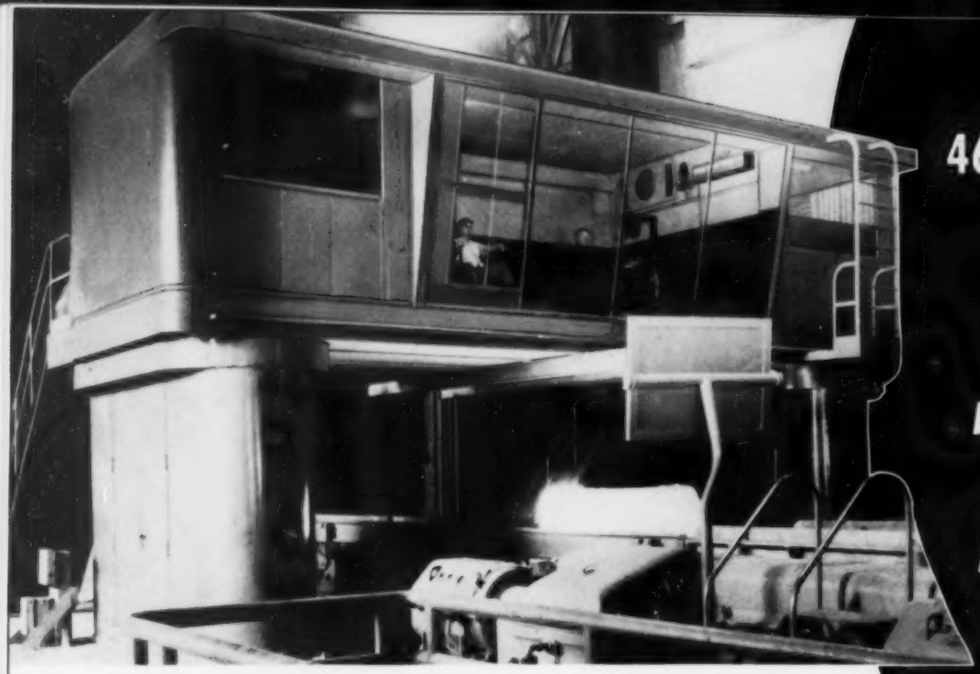


Types HA and I Keystone Contact Rail Insulator — Cast iron base, cemented at factory to porcelain insulator. All metal parts are hot galvanized.

COLLECTORS, CABLE STRAIN CLAMPS, CONTACT RAIL SHOES

ELECTRIC SERVICE MANUFACTURING CO.

1721 CAMBRIA STREET • PHILADELPHIA 32, PENNA.

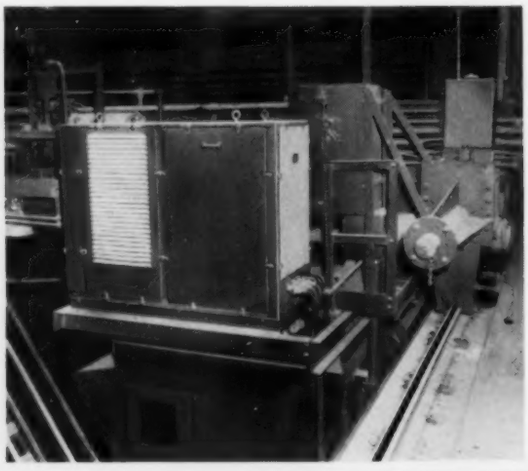


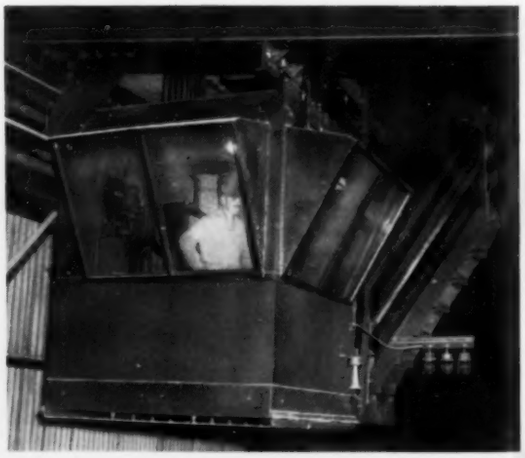
46" Blooming Mill Pulpit *Cooled* by LINTERN AIRE-RECTIFIER

"We couldn't get along without it," said one of the operators, referring to the Aire-Rectifier. It keeps the pulpit at a comfortable 75-80° and provides the men with normal, healthful working conditions—a big help in maintaining high production rates. Humidity-removing Cooling Coil (all copper) shown above man's head in view at left. Condenser is located in one of the pulpit columns.

Bottom-House Crane Cab Conditioned with LINTERN Aire-Rectifier

This air conditioning equipment is most appreciated when working over the drying ovens on hot days . . . keeps cab cool and comfortable. Operator does his work with ease and accuracy. Note how Cab Unit easily fits in the 6' x 6' cab. (Lower left below.) Condenser is located on cantilever beams over door of cab. Lintern Crane Sander in rear. (Below.) Lintern Crane Signal Lights are also shown in cab view. (At right.)





For the past three years this large, modern plant has been using Lintern Aire-Rectifiers with very satisfactory results. Installations have been made in four pulpits, two pit cranes, one stripper crane, one semi-gantry crane, and one bottom-house crane.

THE *Lintern* CORPORATION · *29-2 Riverside Drive, Berea, Ohio*

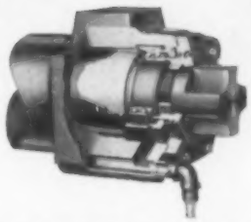
An Invitation . . .

We hope you plan to attend the Convention of the AISE and Iron and Steel Exposition, September 26 - 29 in Cleveland.

We invite you to visit our booth . . . Spaces 344 and 345 . . . and discuss any problem related to increasing production through the use of Morgan equipment.

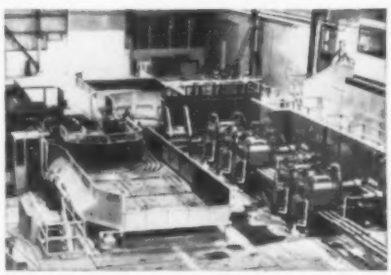
MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS
English Representative: International Construction Company
56 Kingsway, London, W. C. 2, England

IRM-31



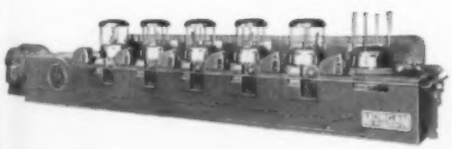
Morgoil Roll Neck Bearings

. . . will increase the accuracy of your product and save on operating and maintenance costs.



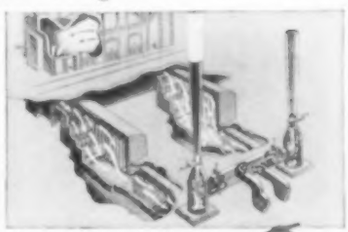
Continuous Rolling Mills

. . . built by specialists with over 60 years of pioneering in the field.



Wire Machines

. . . Morgan-Connors give high production, with low die cost, low power cost, low space requirement.



Furnace Control System

. . . Morgan-Isley increases efficiency of any regenerative furnace at relatively low installed cost.

Air Ejectors

. . . efficiently handle hot gases and fumes as high as 3000° F.

TREADWELL

LADLES

HOT METAL

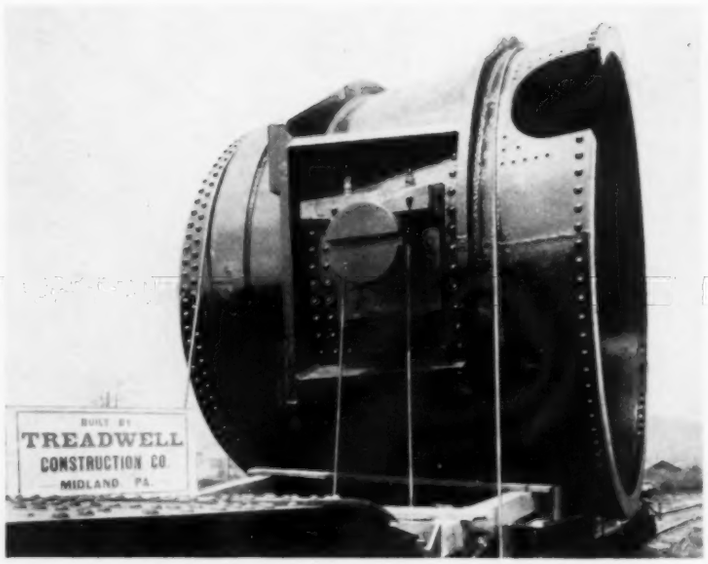
HOT METAL TRANSFER

BESSEMER

OPEN HEARTH

ELECTRIC FURNACE

FOUNDRY



WELDED and RIVETED for the STEEL COPPER BRASS ALUMINUM and ALLIED INDUSTRIES

200 Net Ton Open Hearth Ladles Built for National Tube Co. Lorain, Ohio

TREADWELL CONSTRUCTION CO.
MIDLAND, PENNSYLVANIA

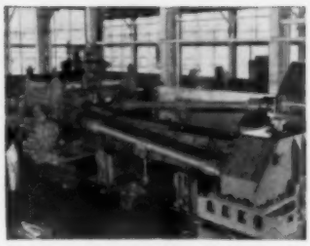
SALES OFFICES

208 S. LaSalle Street
CHICAGO 4, ILL.
CEntral 6-9784

140 Cedar Street
NEW YORK 6, N. Y.
WOrth 4-3344

1217 Farmers Bank Building
PITTSBURGH 22, PA.
ATlantic 1-2883

1. *125 ton ladle crane*



2. *piercing mill*

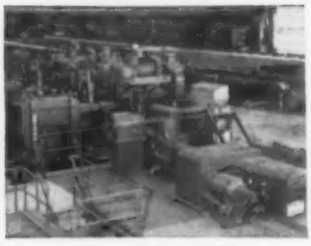
3. *46" blooming mill*

4. *40" bar mill*

5. *billet peeler*

6. *6 stand mill and skelp line*

7. *6 stand mill*



8. *4 stand mill*

9. *15 ton storage crane*

10. *12 stand stretch reducing mill*

11. *9 stand rolling mill*

12. *centerless bar turning machine*

13. *straightening and polishing machine*

14. *cut-off machine*

15. *piercing mill area*

16. *chamfering and threading heads*

How a modern tube mill uses one good idea sixteen times

THE above machines are now in use at one of the country's most up-to-date tube mills. These machines, like most other equipment in the mill, use Timken® tapered roller bearings to assure long, trouble-free, bearing life.

The use of Timken bearings is one good idea you'll find throughout the steel industry. They help insure continuous production with minimum time-out for repair or maintenance. They stand up under the toughest loads. They carry both radial and thrust loads. Because of true-rolling motion and smooth finish, they make friction negligible. Moving parts last longer because Timken bearings hold gears and shafts in positive alignment.

In steel making, and throughout industry, Timken bearings have given years of dependable service under the severest conditions—one reason why they're first choice wherever the loads are tough. Be sure you have Timken bearings in the machines you buy or build. Look for the trade-mark "Timken" on the bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

BE SURE TO VISIT OUR EXHIBIT AT THE IRON AND STEEL EXPOSITION, BOOTHS 104, 105, 106, 107

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION →✳←

ON BLOOMING MILLS TOO

. . . Morgoil Bearings are setting new records for efficiency and economy of operation. These pictures show a very satisfactory Morgoil installation in two mills of the National Tube Company—Lorain Works.

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS
English Representative: International Construction Company
56 Kingsway, London, W.C. 2, England MB-15

MORGAN WORCESTER
ROLLING MILLS
MORGOIL BEARINGS
WIRE MILLS - GAS PRODUCERS - AIR EJECTORS
REGENERATIVE FURNACE CONTROL

MORGOIL
ROLL NECK BEARINGS

Proud to Serve

NATIONAL TUBE COMPANY ...ON A 24-HOUR BASIS

• Yes, indeed, Airco is proud to be associated with the National Tube Company at its Lorain Works and to serve its demand for 99.5% pure oxygen.

The customer's internal pipeline, carrying by far the greater part of the demand, is supplied in this case from an Airco oxygen plant immediately adjacent to the National Tube property. The supply is accurately measured—always available for use. In addition to this constant gas flow, Airco is able to serve any point in the plant with an accurately-measured oxygen supply by using a temporary trailer set up should the mill find it necessary to alter or add to their present pipeline system. This permits a constant, uninterrupted gas flow at all times—*without stopping mill production.*

Further, Airco's extensive knowledge of steel mill operations enable them to give National Tube the extra "plus value" services that go to every Airco oxygen user. For example, these time-and-money saving services were performed for various departments throughout National Tube:

1. In the Bessemer Department — with portable trailers, oxygen was supplied in quantities over 1000 ft. per minute for special combustion tests in the furnaces. Trained Airco specialists assisted in these tests, lending their experience gained over a period of years.

2. In the Open Hearth — a demonstration on how a heavy-duty hand cutting torch and oxygen lance could be combined to reduce large buttons and skulls to charging box size... again, portable trailer equipment enabled these tests to be conducted *without stopping mill production.*

3. Fuel and Power Department — complete overhaul of oxygen pipeline system to eliminate costly leaks, and provide a high safety factor. Moreover, constant checks are made on operator technique and equipment, and repair men are instructed in the proper methods of repairing all equipment.

But these are only a few of the services performed by Airco in their around-the-clock assistance to National Tube. Airco has performed similarly for the bloom yard, blast furnace department, steel conditioning department, foundry, skelp mill and metallurgical laboratory.

Let Airco help you. Remember oxygen use is growing by leaps and bounds. Keep pace with the latest steel mill technique and processes. Ask to have an Airco Technical Sales Service Representative help *YOU*... his years of steel mill experience permit him to advise the right type of equipment, or the right quantity of oxygen to do the best job—most economically—to solve your particular problem. Write your nearest Airco office, today.

AIRCO AIR REDUCTION
Offices in Principal Cities

OXYGEN IS OUR BUSINESS... AND WE'RE PROUD TO PRODUCE IT... 99.5% PURE

Handling Heavy Rounds at National Tube Made-to-Order Job for STEARNS Lifting Magnets

Lifting and moving five steel rounds in the Bar Mill of the National Tube Company, Lorain, Ohio, is everyday work for this STEARNS 65" circular lifting magnet. Each of these rounds is 10½" in diameter and 12'6" long and weighs 3680 lbs. — a total weight of more than 9 tons!

This is but one example of the many installations of STEARNS circular and rectangular lifting magnets. STEARNS lifting magnets are being successfully and profitably used in handling steel plates, bundles, strip steel, rails, slabs, billets, pig iron, castings, borings, turnings, scrap iron as well as finished products.

If you want to move large quantities of material quickly and at a low cost — investigate STEARNS lifting magnets. They will pay for themselves in a short time, require surprisingly little attention, and are your best bet for economical, fast and safe moving of material.

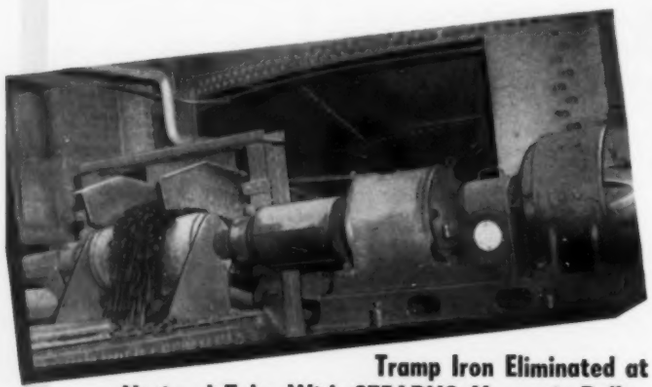
Stearns LIFTING MAGNETS SAVE MAN HOURS!

ECONOMICAL

You can cut down the time for moving hard to handle materials and make a direct saving of hand labor with STEARNS lifting magnets. Standard sizes available in both bolted and all welded constructions. Special sizes and shapes made to your requirements.

NO TRAMP IRON · NO BREAKDOWNS!

Take your cost-cutting cue from this installation at the National Tube Co., Lorain, Ohio. Avoid costly damage to crushers, grinders, screens and other expensive equipment by using a STEARNS electro or permanent magnetic pulley. Write today for descriptive literature on STEARNS *EXPERIENCE ENGINEERED* magnetic pulleys and pulley separator units.



Tramp Iron Eliminated at National Tube With STEARNS Magnetic Pulley

STEARNS magnetic pulleys are on the job at National Tube, too. Here is a STEARNS 12" x 24" electro-magnetic pulley removing all tramp iron from coal about to be pulverized. Expensive crushers and screens are protected by continuous and automatic tramp iron removal. If you want to reduce shut-down time and keep repair charges to a minimum — install a STEARNS Magnetic Pulley, the only economical insurance against the tramp iron nuisance.

LARGEST!

Whether your needs are large or small, STEARNS has a pulley for you. Here's the World's Largest Electro-Magnetic Pulley — 60 inches in diameter, 36 inches wide.

SMALLEST!

This is our smallest standard pulley; 12 inches high, 12 inches wide.

STEARNS MAGNETIC MFG. CO.
681 SOUTH 28th STREET • MILWAUKEE 46, WISCONSIN

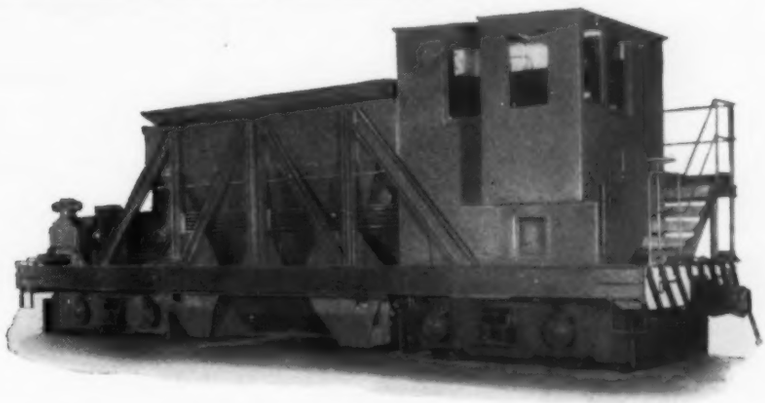
Stearns MAGNETIC
ELECTRO AND PERMANENT
PULLEYS • DRUMS • SPOUTS • FILTERS CLUTCHES • BRAKES • LIFTING MAGNETS

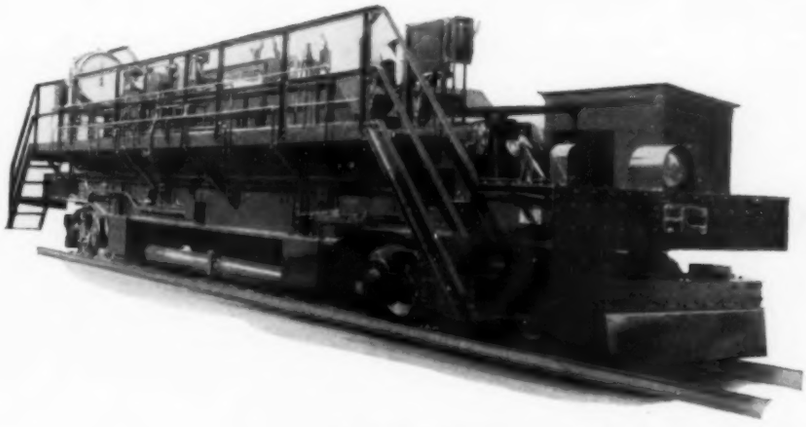
ATLAS

HAULAGE EQUIPMENT

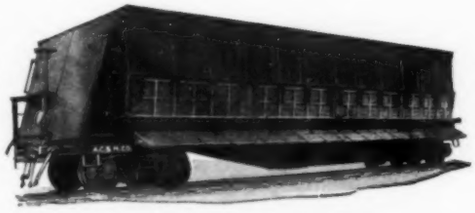
DEMONSTRATES DEPENDABILITY and EFFICIENCY at the NATIONAL TUBE CO.

50-TON CAPACITY
BOTTOM DUMP
ORE TRANSFER CAR





40-TON
SCALE CAR
BOTTOM DUMP



COKE QUENCHING CAR

40-TON

PUSHER LOCOMOTIVE

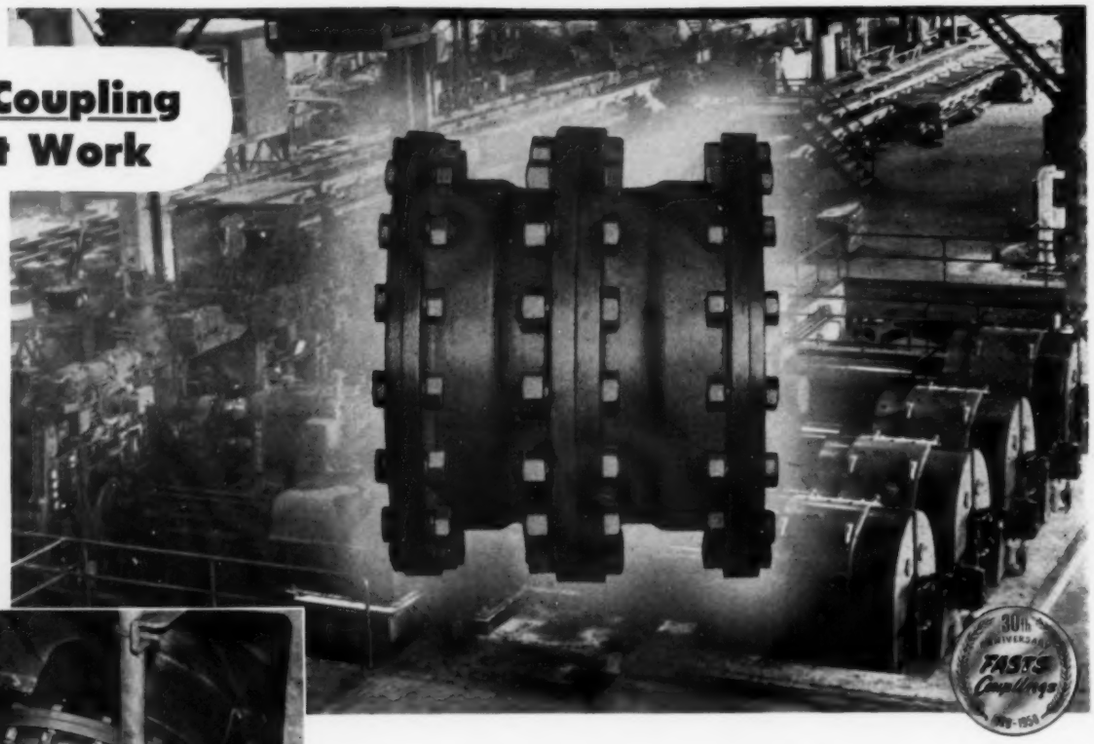
BUILDERS OF: Scale Charging Cars and Ore Transfers; Indicating and Recording Dials for Weighing Scales; Electric and Storage Battery Locomotives; Coal Charging Cars; Door Extractors; Coal Quenching Cars; Turntables.

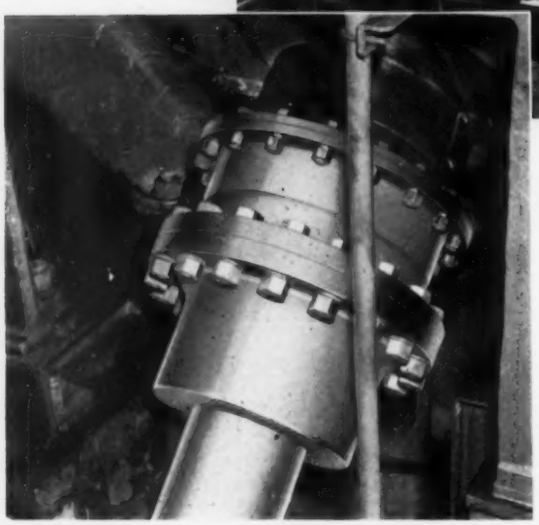
THE ATLAS CAR & MFG. CO.

ENGINEERS
1140 IVANHOE RD.

MANUFACTURERS
CLEVELAND 10, OHIO, U. S. A.

Koppers Coupling Service at Work





NATIONAL TUBE CO. uses a variety of special and standard Fast's at its Lorain Works. This Fast's Coupling on the upper bevel gear drive of a 4-stand vertical mill is typical of the unusual applications.

How FAST'S COUPLINGS Keep Production High

at Lorain Works of National Tube Co.

Coupling failures at the Lorain Works of National Tube Co. would be poison to production. That's why management specified Fast's Couplings for critical equipment—to insure that production of stainless steel tubing *would not stop* because of a coupling failure.

Fast's Couplings can assure the same trouble-free performance for your plant. Fast's have been on the market for 30 years and accurate records prove Fast's usually *outlast the equipment they connect.* And now Fast's are backed by Koppers Engineering Service, a valuable coupling service which shows you *which* coupling to buy and *why.*

No matter what type coupling you need—shear pin, floating shaft, cut-out, heavy duty, reversing or high speed—specify Fast's. Full details, descriptions and installation photos are contained in the Fast's Catalog. For your free copy *write today to:* KOPPERS CO., INC., *Fast's Coupling Dept.,* 219 Scott Street, Baltimore 3, Md.

These FAST'S COUPLING *Services save you money!*

Unsurpassed Engineering . . .
Koppers' engineers are acknowledged the best in the industry. Their practical knowledge, backed with 30 years' coupling experience, is at your service!

Prompt Delivery . . .
All standard types and sizes are available for prompt delivery from "on hand" stocks. In case of emergency, just wire factory for special rush delivery!

Lowest Cost Per Year . . .
Fast's Couplings will outlast equipment they connect if properly maintained. Their cost may be spread out over 25 years or more, offering you lowest coupling cost per year!

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FAST'S
THE ORIGINAL
GEAR-TYPE
Couplings

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The Youngstown Foundry & Machine Co.

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OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

DELTA-STAR METAL-ENCLOSED BUSES FOR ALL REQUIREMENTS

TO GET THE BEST BUS CONSTRUCTION TO MEET YOUR PARTICULAR NEEDS DISCUSS THE PROBLEM WITH DELTA-STAR

A variety of "Unit-Type" metal-enclosed bus designs, in voltage ratings up to 23-kv and current ratings as high as 6000 amperes are available. Each type offers particular advantages.

Delta-Star has designed and manufactured many types of buses for important utility and industrial installations. Its staff of experienced engineers will make an analysis of your proposed installation and determine whether isolated phase, segregated phase or non-segregated phase construction will be the most economical for the service requirements.

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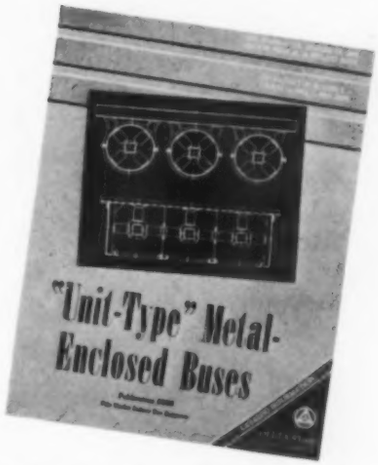
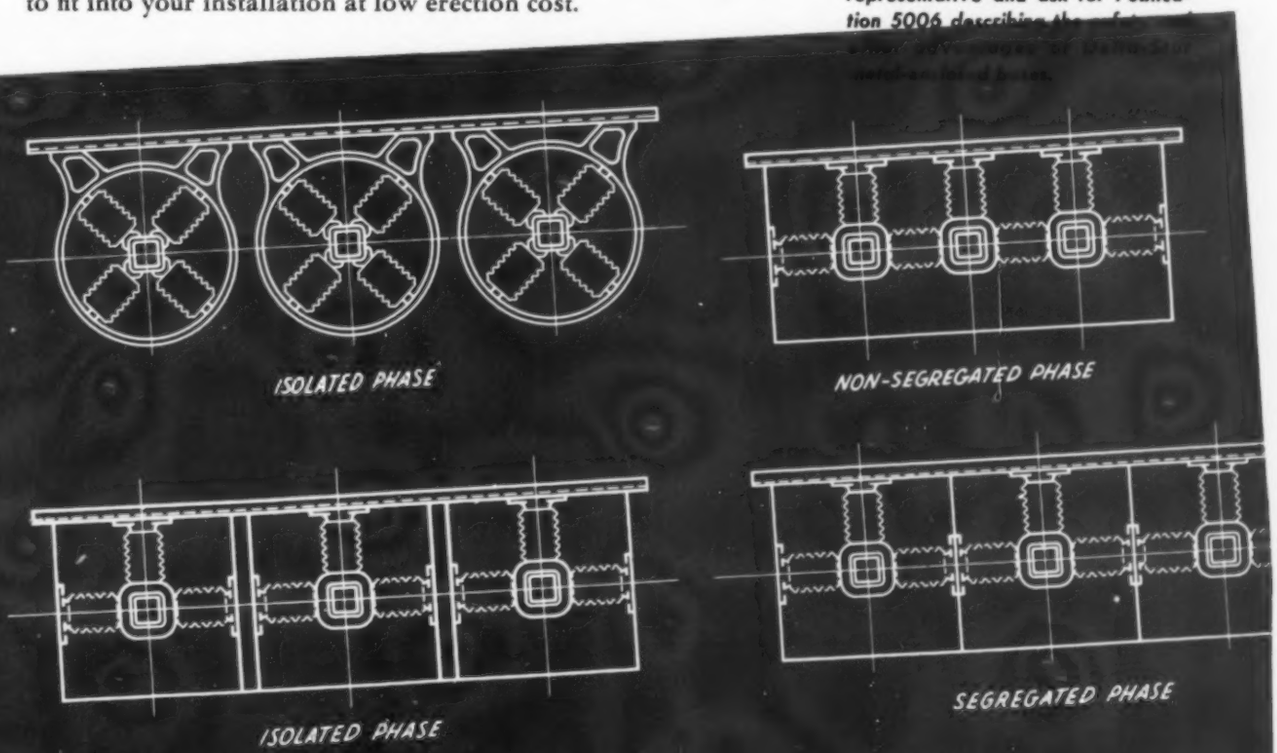


Call or write the factory or nearest representative and ask for Publication 5006 describing the



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CANADIAN ASSOCIATE

Canadian Line Materials Limited — Toronto 13, Canada

At the Lorain Works of National Tube Company

Ampco Metal is specified for a variety of jobs where its high resistance to pressure, shock, and fatigue pays off in long-wearing economies. Shown here is one of 8 Ampco Grade 18 guides which take the lateral pressure of the top roll on the No. 4 Blooming Mill illustrated below.

AMPCO METAL

Ampco-Cast-to-Size Slippers are furnished +1/32"—0" or —1/32"+0" tolerance with oil grooves "cast-in" to requirements. Accurate surface finishes eliminate necessity for machining.

(Above) Grade 18 Ampco Cast-to-Size Slippers are used in the Universal Joints of this seamless piercing mill at the Lorain Works.

(Below) in the same piercing mill Ampco Grade 18 internal and external nuts are used for height adjustment controls.

stands up longer in steel mill service...

Yes, Ampco Metal is a "tough customer." It has to be—to take the terrific beating of steel mill pressure loads, shock, and fatigue. You can't beat it for rugged wear-resistance. That's why more and more mills (like the Lorain Works) specify Ampco Metal to cut maintenance service, down-time, replacement costs, and production losses.

Protect your production schedules. Insist on wear-resistant Ampco metal (aluminum bronze) for wear plates, slippers, screwdown nuts, flash welder dies, pickling equipment — and other proven spots where Ampco's extra toughness pays off in reduced costs.

AMPCO METAL, INC., Dept. IS9, Milwaukee 46, Wisconsin

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For more cost-cutting information visit Booths 41-42
IRON & STEEL EXPOSITION, SEPT. 26-27-28-29
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It's LOFTUS All along the Line

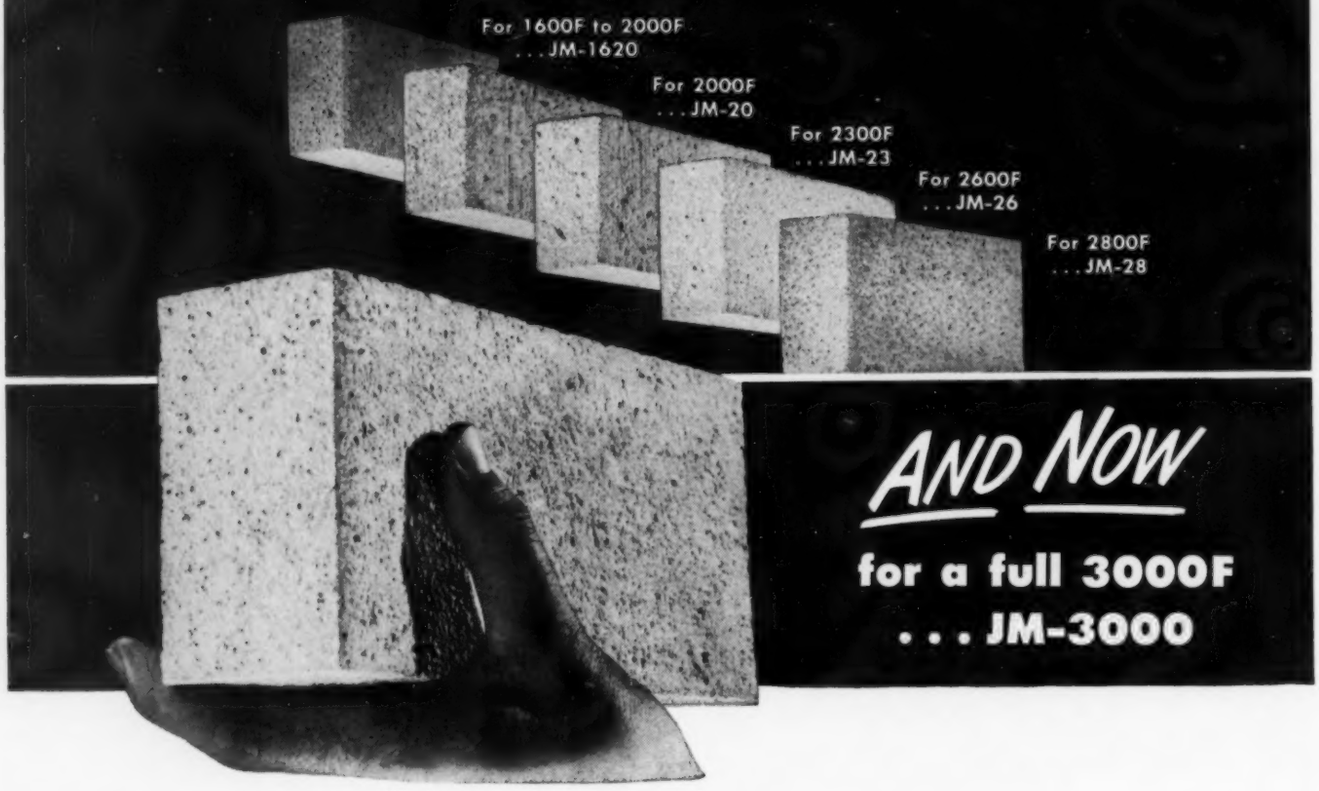
This modern Slot Type Furnace designed and built by Loftus and installed at The Lorain plant of the National Tube Co. is one of the largest in the country.

From Open Hearth, Soaking Pit, Reheating Furnaces to Heat Treatment Furnaces—Loftus serves all along the production line.

610 SMITHFIELD ST. **LOFTUS ENGINEERING** *Corporation* PITTSBURGH, PA.

Designers and Builders of Industrial Furnaces

MEET the family of Johns-Manville Insulating Fire Brick . .



AND NOW for a full 3000F . . . JM-3000

HERE IS AN OUTSTANDING FAMILY of insulating fire brick for back-up or exposed use . . . the only family of its kind . . . that gives you a complete range . . . a *quick heating* insulating fire brick for every purpose.

By taking advantage of the quick heating characteristics of these insulating fire brick, you'll benefit through important savings in fuel because of the quicker rise to proper operating temperature in the furnace. This is a result of the low heat storage capacity and low thermal conductivity characteristics of the brick. These factors are especially important where furnaces are being intermittently operated.

The same materials can also be obtained in large size units as Johns-Manville Insulating Fireblok. This product has many advantages over the smaller size fire brick, from both a construction and stability standpoint. They can be quickly applied because they are easy to cut and fit. J-M Insulating Fireblok provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

Why not have a Johns-Manville insulation expert call to tell you more about ways in which you can save by using these insulations in your furnaces. Write Johns-Manville, Box 290, New York 16, N. Y. for further information.

	JM-1620	JM-20	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	35	42	48	58	63-67
Transverse Strengths, psi	60	80	120	125	120	200
Cold Crushing Strengths, psi	70	115	170	190	150	400
Linear Shrinkage,† percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.22	1.91	2.22	2.50	3.20
1500 F	1.27	1.47	2.31	2.52	3.00	3.35
2000 F	—	1.72	2.70	2.82	3.50	3.60
Recommended Service						
Back up	2000 F	2000 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

† *24-hr simulative service panel test for JM-3000, 24-hr soaking period for other brick.*

* *Conductivity is expressed in Btu in. per sq ft per F per hour at the designated mean temperatures.*

Note: Above tests are in accordance with A.S.T.M. tentative standards.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville First in INSULATIONS

FOR *Precision* STRAIGHTENING....

THIS SUTTON STRAIGHTENER
is at work in the
CONTINUOUS SEAMLESS MILL (No. 4)
of the **LORAIN WORKS**
NATIONAL TUBE COMPANY

YES—for accuracy—for rugged dependability under pressure of full scale production—the LORAIN WORKS of NATIONAL TUBE COMPANY chose this SUTTON 2BM, 5-roll, Rotary Straightener.

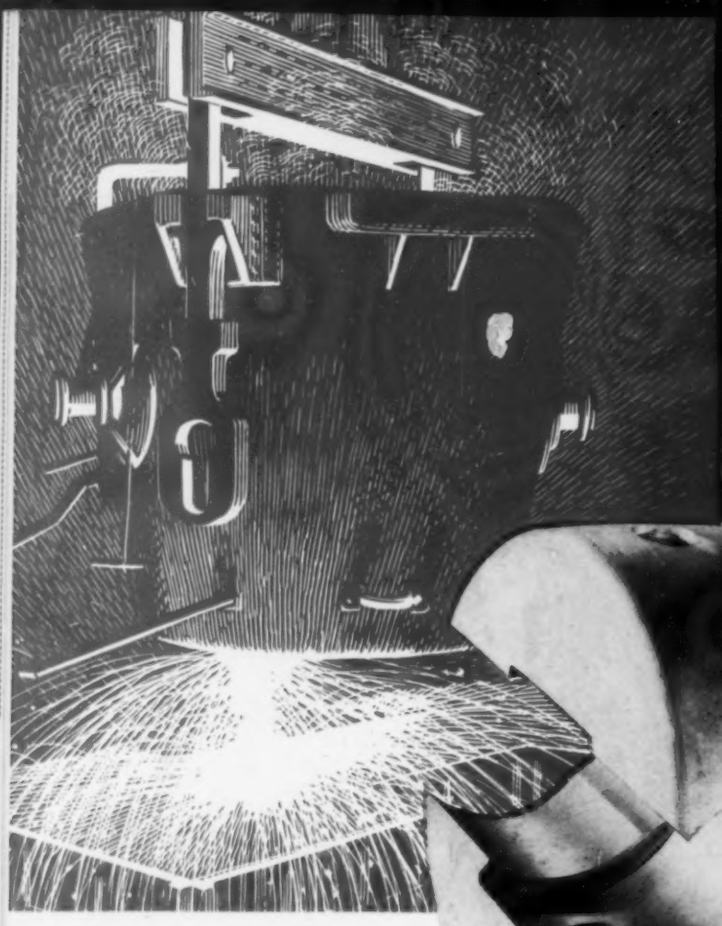
Typically—it's a highly successful installation, straightening boiler tubes in sizes from 1.900″ O.D. to 5″ O.D., in lengths up to 50 feet, at a production speed of 100 to 400 feet per minute.

WRITE FOR PROPOSAL

● Specific information will be given in answer to any straightening problem you may have. There is no obligation for this service.

SUTTON
Engineering **COMPANY**

Manufacturers for Ferrous and Non-Ferrous Industries
Bar and Tube Straighteners, Sheet Levellers, Hydraulic Stretchers, Gag Presses, Rotary Cleaners, Heavy-Duty Universal Joints, Rolls.
BELLEFONTE, PENNSYLVANIA



Cast UNIVERSAL COUPLINGS AND SPINDLES *give you these advantages:*

"UNION" MAKES BETTER:

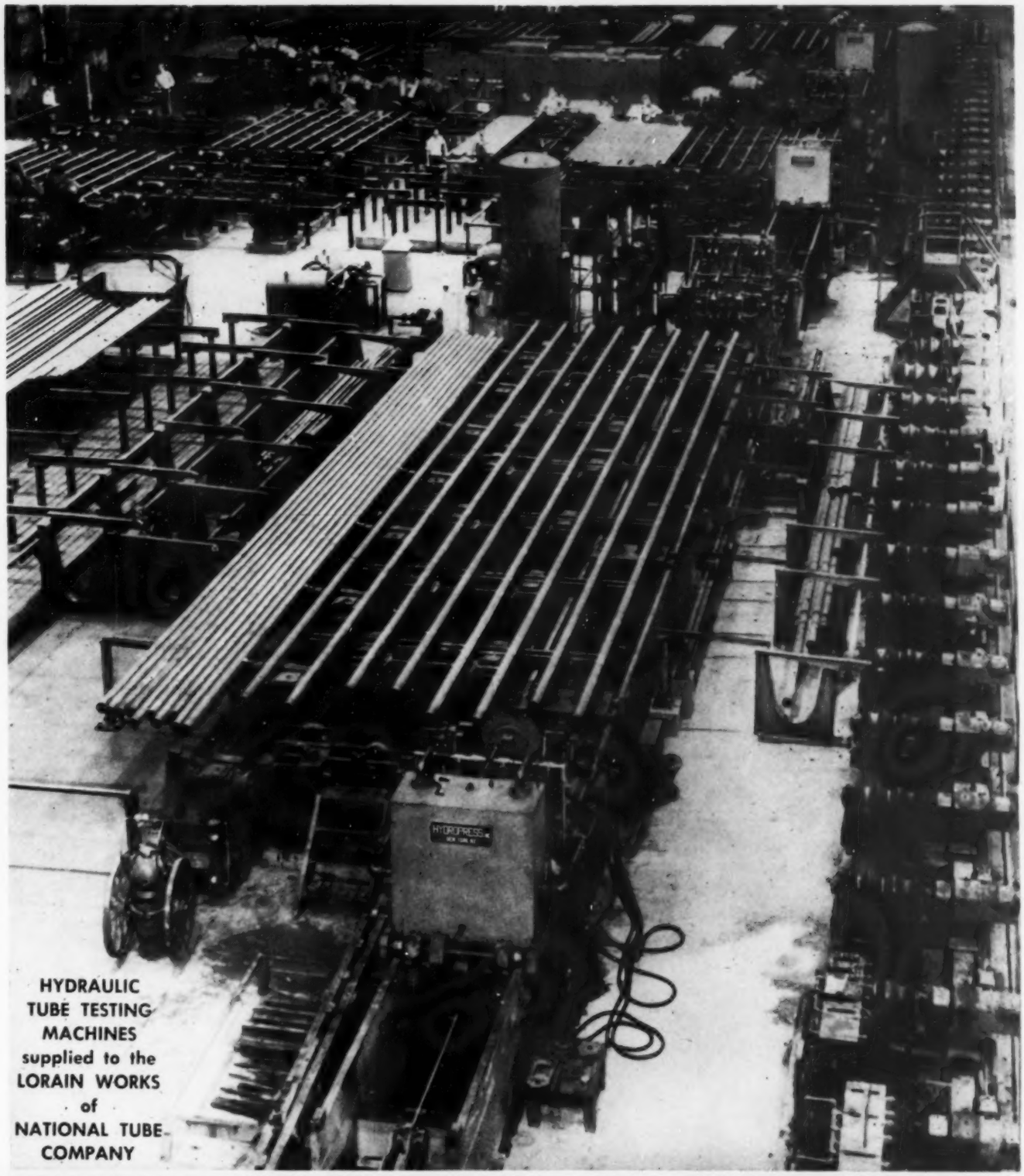
CHARGING BOXES . . . PEELS
INGOT CARS
CHARGING BOX CARS
COUPLING BOXES AND SPINDLES
GEARS AND PINIONS
BLAST FURNACE BELLS
SPECIAL ALLOY CASTINGS FOR ROLLING MILL EQUIPMENT

1 Less Cost . . 2 Last Longer . . 3 Easier to Machine
4 Less Down-Time for Replacement

Those are not boastful claims, but the actual experience of many mill superintendents on the lookout for production economies. We welcome the opportunity to have you prove to yourself the advantages of Universal Couplings and Spindles cast from high-strength "Univan" or Armor Steel . . . Before your next replacement, let us give you the facts and figures on a "Union" casting to your exact specifications—either in the rough or completely machined.

UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX COMPANY . . . PITTSBURGH 22, PA.



HYDRAULIC TUBE TESTING MACHINES supplied to the LORAIN WORKS of NATIONAL TUBE COMPANY

HYDROPRESS · INC ·

ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ACCUMULATORS · PUMPS

ROLLING MILLS

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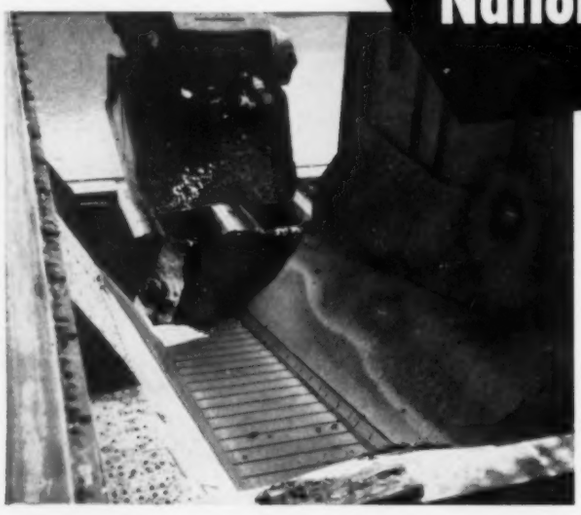
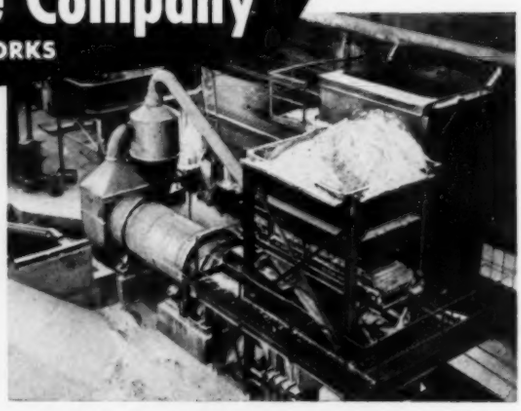
LINK-BELT AT WORK

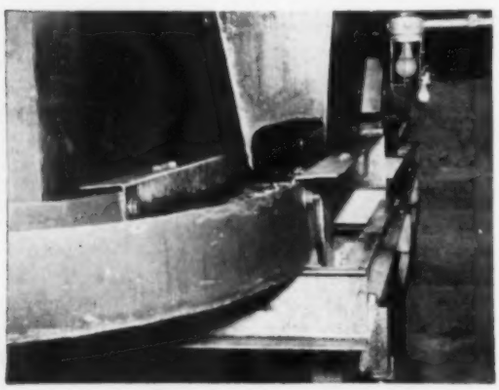
National Tube Company
LORAIN WORKS



One of the two 72-inch, heavy duty, Link-Belt apron conveyors mounted on Hulett unloaders, each of which receives 25-ton ore loads from the buckets.



Link-Belt Roto-Louvre Dryer dries 8000 pounds of ammonium sulphate an hour. Unit is complete with crane dump hopper, No-Leak apron feeder and two-roll crusher.



One of the Link-Belt oscillating conveyors under the threading machines which provides a positive and continuous transfer of chips.

At the Lorain Works of National Tube Company, Link-Belt equipment such as illustrated, gives smooth, efficient, dependable performance. From broad experience in designing and building materials handling and preparation, and power transmission machinery of every type, Link-Belt engineers bring to current problems an unusual fund of knowledge, which, coupled with unsurpassed manufacturing facilities, assures their effective solution.

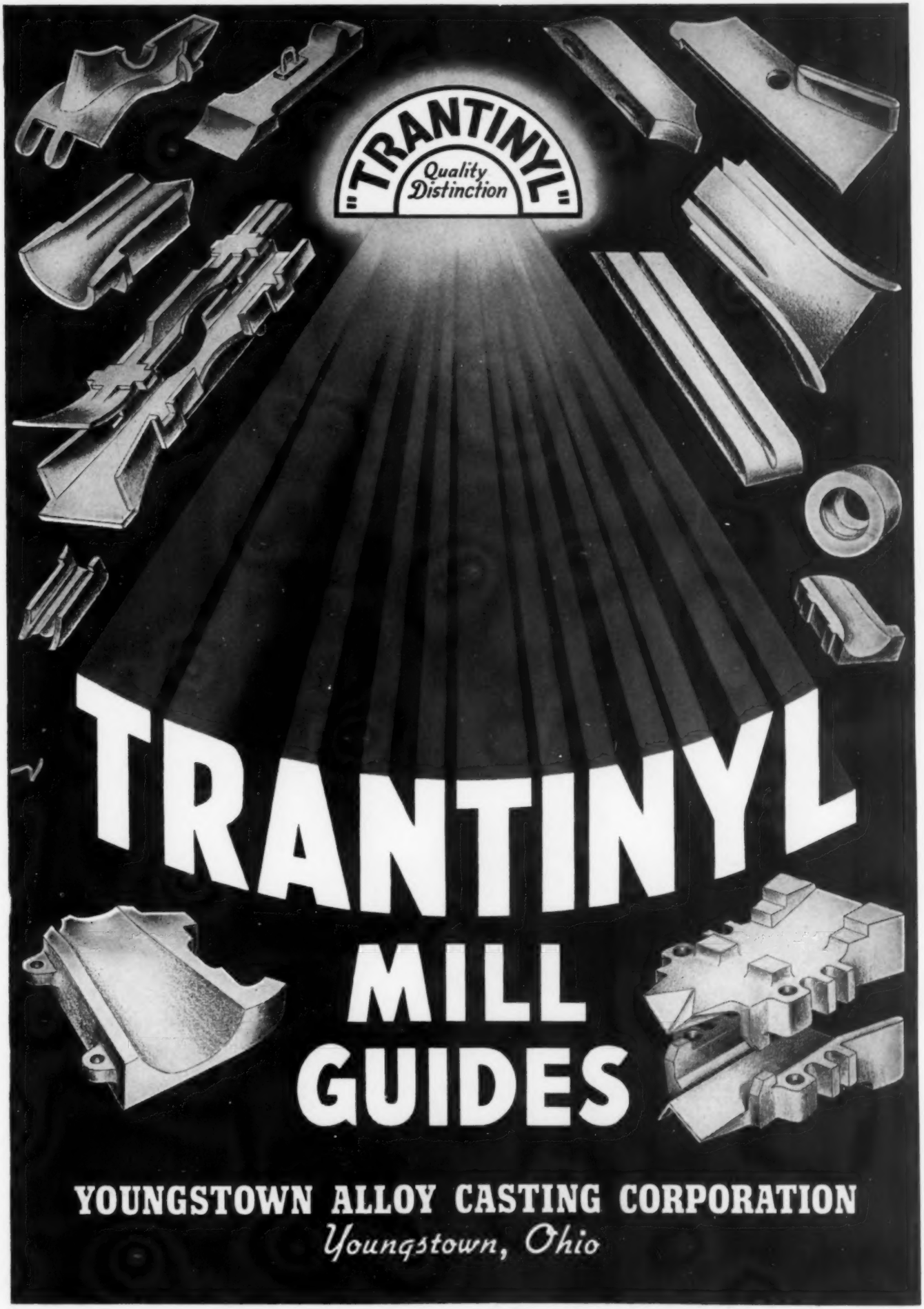
12,094

LINK-BELT COMPANY

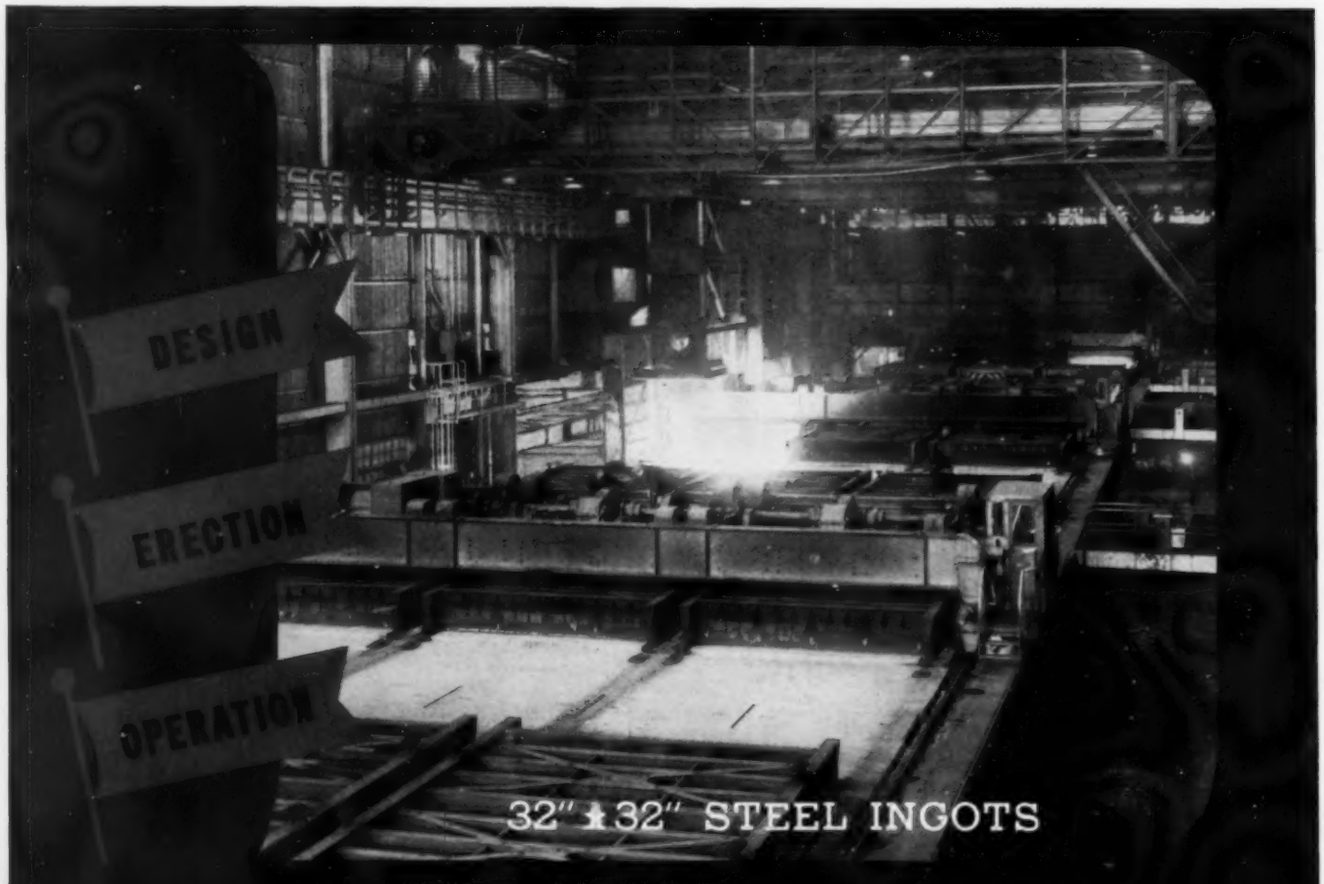
Chicago 9, Indianapolis 6, Philadelphia 40, Cleveland 15, Pittsburgh 13, Atlanta, Dallas 1, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

LINK-BELT

CONVEYING MACHINERY
"THE COMPLETE LINE"


"TRANTINYL"
Quality Distinction
TRANTINYL
MILL
GUIDES
YOUNGSTOWN ALLOY CASTING CORPORATION
Youngstown, Ohio

24 AMCO Recuperative Bottom Fired Pits

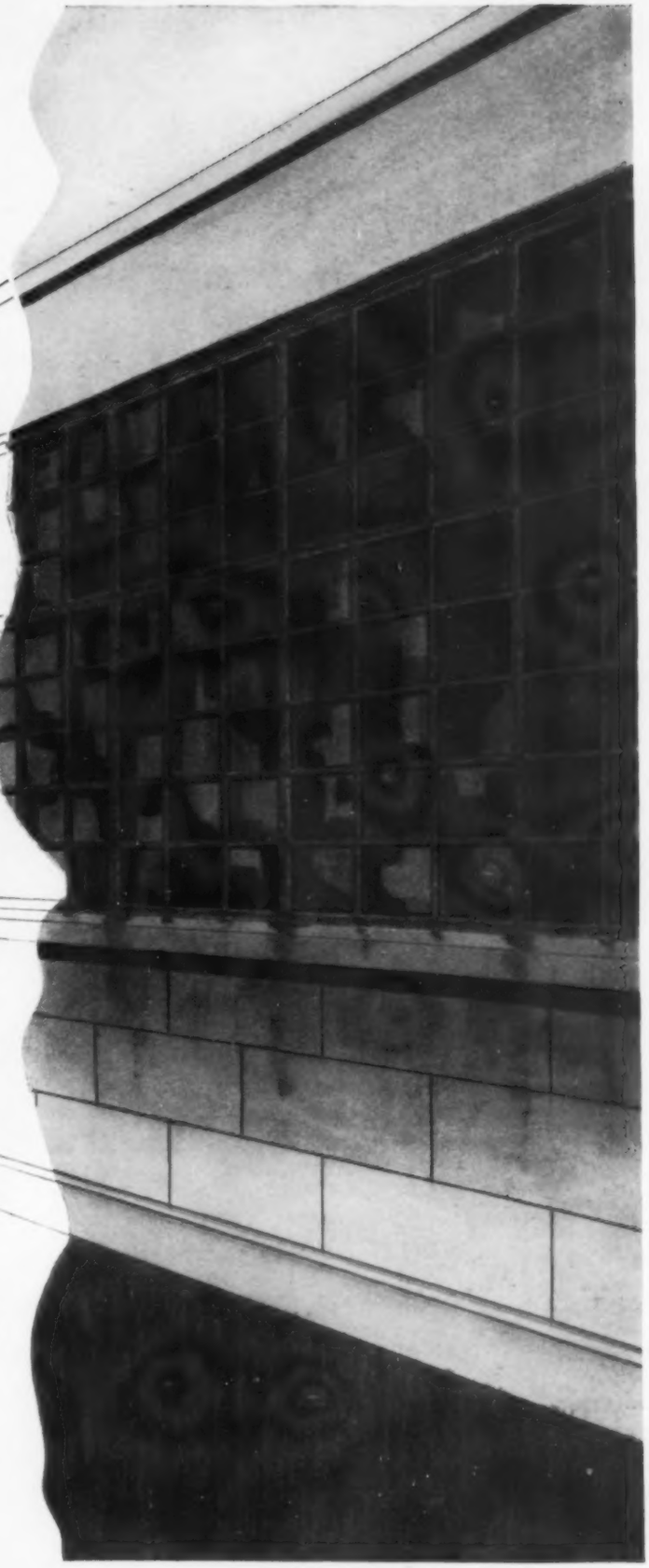


Over 25% of The United States of America Ingot Production Heated in the AMCO Soaking Pits.

Amsler Morton Corp.

Chamber of Commerce Bldg., PITTSBURGH, PENNA.

DON'T BLAME YOUR PAINTING CONTRACTOR



You've often seen unsightly rust stains from metal sash on the adjacent brick and stone surfaces. You need never blame your painting contractor for unsightly stains caused by rust! You can *prevent* rust . . . and at no extra cost . . . simply by specifying RUST-OLEUM as the *shop coat, primer and finish coat* on all metal rust can attack.

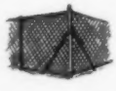
But, specify Rust-Oleum in the *first stages* . . . when design, engineering and contracting take form . . . before actual delivery of material for the job. Rust-Oleum costs no more than quality material you may now be using . . . and is easy to apply at no added expense.

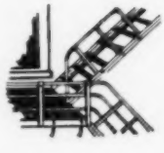
Rust-Oleum is tested and proved by a host of nationally known users. Rust-Oleum *stops* and *prevents* rust! RUST-OLEUM protects metal from rust with a tough, pliable film that dries to a firm finish. Rust-Oleum defies sun, rain, snow, salt air, smoke, fumes and other rust-producing conditions . . . and adds longer life wherever it is used. Girders, plates, stacks, gutters, roofs, tanks . . . every metal surface can be protected surely, safely and *economically* with RUST-OLEUM.

Rust-Oleum *beautifies as it protects* because it is available in many attractive colors including aluminum and white. Rust-Oleum can be applied to already rusted surfaces with minimum preparation . . . *it is not necessary to remove every appearance of rust!*

So, take the sure way to stop rust. Specify Rust-Oleum on all rustable metal, inside or out. It costs less ALL WAYS to do the job right.

Rust-Oleum is stocked and sold by leading industrial distributors in all principal cities of the United States and Canada. See Sweets for complete catalog and nearest source of supply, or write us direct for complete information.





Architects, Engineers, Builders

If you have a client with a rust problem, and would like a free survey and recommendations, send his name and address on your business stationery. A qualified Factory Representative will arrange this FREE Service, and it includes a trial size of Rust-Oleum for specific test purposes. There's no obligation on your part. Write today.

**Names on request*

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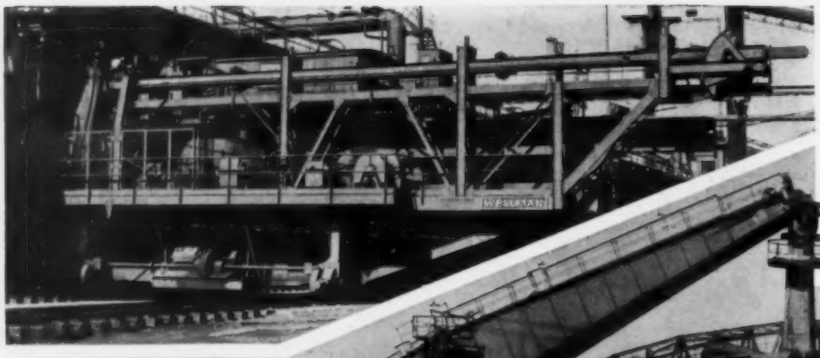


Top—*Wellman Coke Pusher at the Lorain Works.*

Center—*One of two Wellman 20-ton Hulett-Type Ore Unloaders at the Lorain Works.*

Bottom—*Three Wellman 12-ton Low-Type Open Hearth Charging Machines at the Lorain Works.*

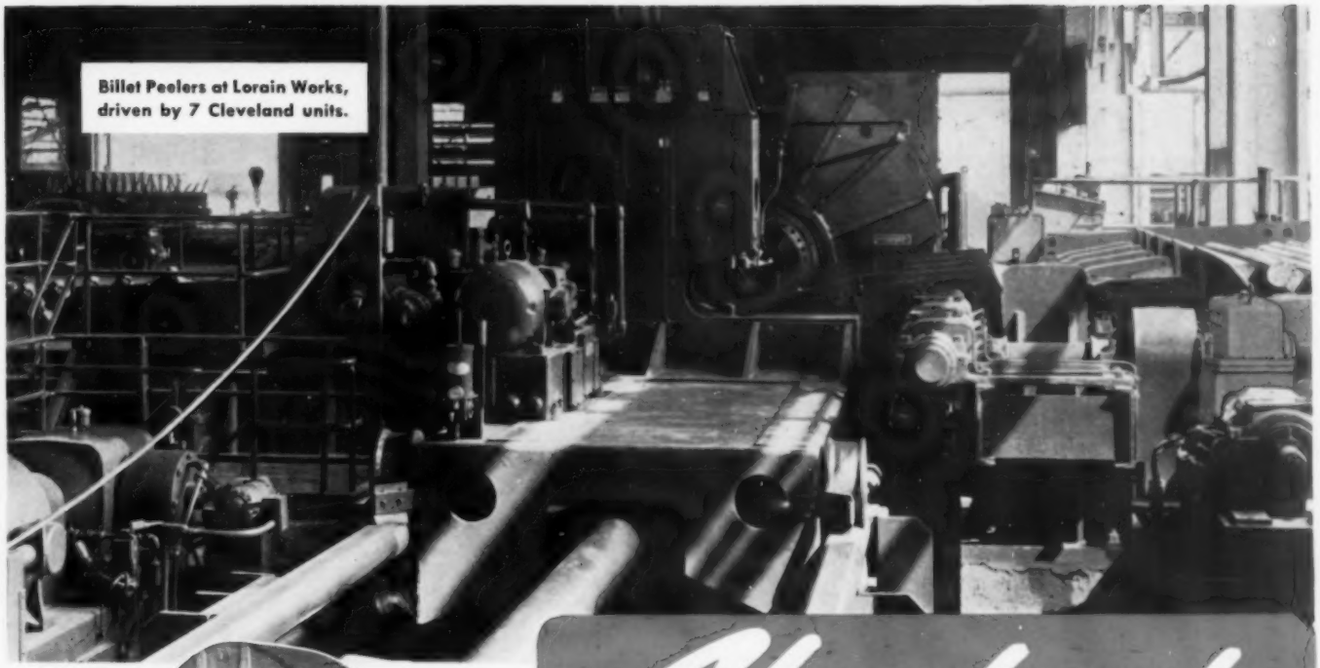
How Wellman serves the Lorain Works

● These pictures show three important applications of Wellman equipment at the Lorain Works of National Tube Company. These installations are typical of the contributions which Wellman has made to the steel industry for more than 50 years.

Wellman is recognized the world over as a pioneer and leader in the engineering, manufacturing and installation of heavy duty machinery for the steel industry. We welcome your problems.

THE WELLMAN ENGINEERING COMPANY

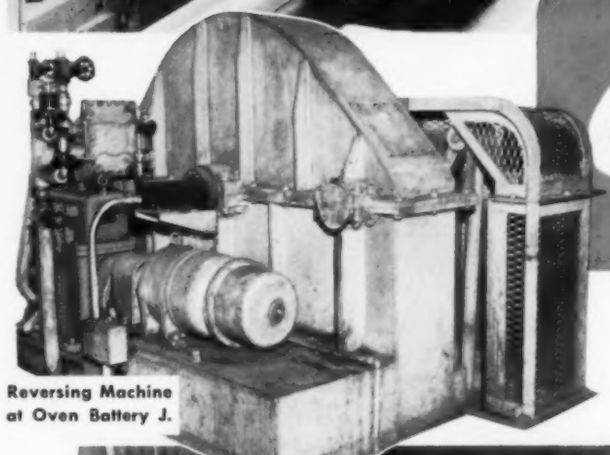
7031 CENTRAL AVENUE • CLEVELAND 4, OHIO



Billet Peelers at Lorain Works, driven by 7 Cleveland units.

Clevelands

AT NATIONAL TUBE — LORAIN



Reversing Machine at Oven Battery J.

CLEVELAND service to National Tube Company at Lorain dates back to 1920, when 9 worm-gear speed reducers were installed. Since then hardly a year has passed without more Cleveland units going in.

Over 200 Cleveland drives are employed in the new No. 4 Seamless Mill and No. 4 Blooming Mill projects.

Wherever they are installed—here at the Lorain Works, as well as at National Tube's other plants and throughout the steel industry—iron and steel engineers know that they can depend on Cleveland Worm Gear Speed Reducers for dependable service.

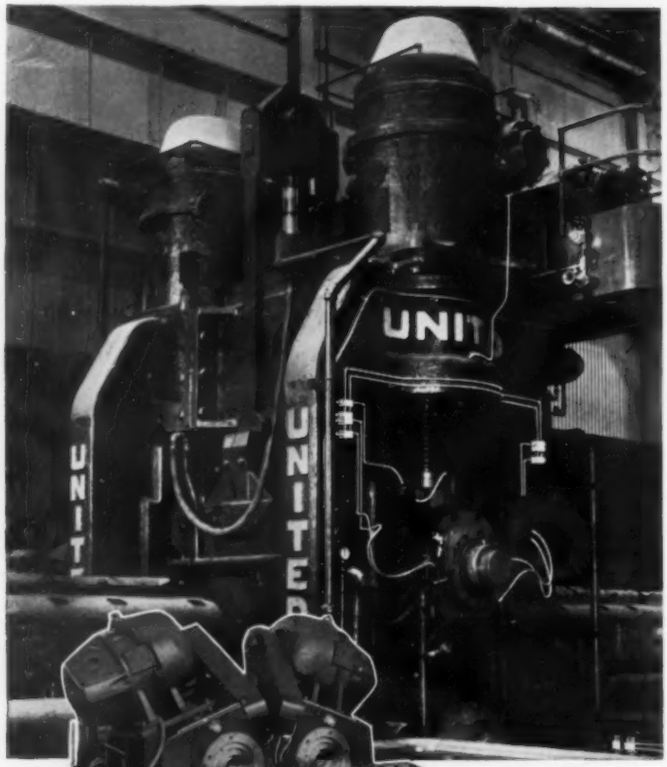
The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

Cleveland Type CU unit, driving Cooling Tower fan.

The new 46″ Mill room, showing Cleveland equipped Bloom Pusher.

FARVAL protects over 8,000 bearings at National Tube's Lorain plant



● Farval Centralized Lubrication Systems protect bearings throughout National Tube Company's No. 4 Seamless Mill and No. 4 Blooming Mill.

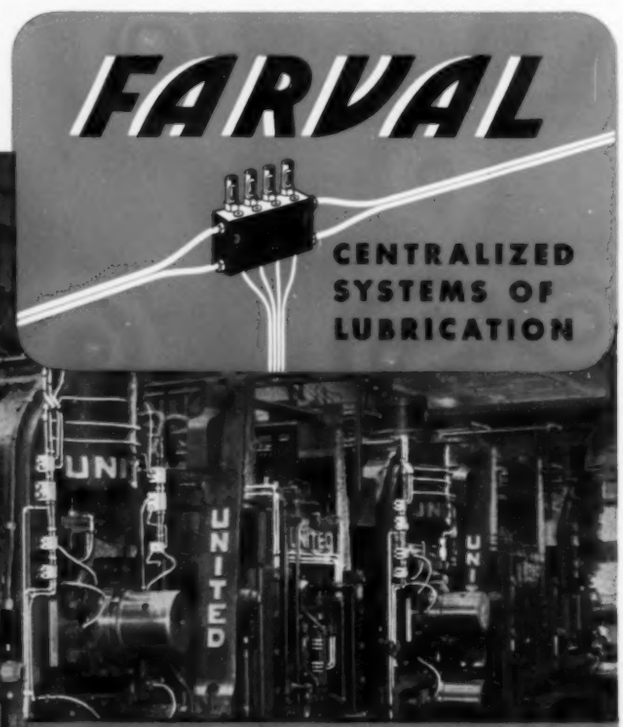
In the recently completed projects at Lorain, Farval automatic and manual systems serve more than 8,000 bearings—on the blooming mill, bar mill, billet mills, shears, pushers, peelers, piercers, elongating mills and sizing mills, tables, cooling beds, threading and chamfering machines and other equipment.

In this plant, as in hundreds of other steel and metal-working plants, Farval Centralized Lubrication has long since proved its ability to save time, lubricant and oiling labor, eliminate bearing expense, and most important of all, reduce down time for bearing replacement or repair, and thereby increase mill and machine production.

Where it is important that bearings function dependably under heavy pressures and at high speeds, you'll find Farval on the job.

The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate of the Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Ltd.



FARVALIZED EQUIPMENT AT LORAIN

Top, left—46" Blooming Mill.

Middle, left—Pipe threading machine.

Bottom photo—Six-stand 4-high billet mill.

Saving Time in Rebuilding Blast Furnaces

. . . . the ability of operators to rebuild the blast furnace in shorter times has in effect added to the pig iron productive capacity of the country . . . .

By T. A. LEWIS
Superintendent, Service Div.
Bethlehem Steel Co.
Bethlehem, Pa.

▲ DURING and following the war the demand for iron and steel products was so great that the facilities used to produce these products had to be repaired in the shortest time possible.

This pressure for getting the facilities back into production resulted in the devising of many schemes and methods for doing these jobs. An added problem, especially during the war, was the lack of man-power to do this work. Thus, many of the schemes to be shown in the following had the objective of reducing man-power requirements so that the job was not unduly prolonged from this cause. Thus, by reducing man-power as well as length of time on various operations, economies were possible even in the face of increasing costs.

One of the first problems attacked was the removal of stack lining after the furnace was blown out. In the Bethlehem plant we applied a loading machine similar to that used in mines (Figure 1), to facilitate this work. This machine is used to remove the entire lining as well as the stock from below the mantle which was left in after the blowout. It is estimated that two days of elapsed time are saved, as well as 1000 man-hours per relining, in this operation. Other plants use bulldozers, or a dozer-shovel.

The removal of stack lining down to the mantle previously required 15 to 18 men per shift, working about a week with paving busters and bars. By the use of rigging, we are able to remove the lining in about two days time with a force of six men. A two-drum hoist engine is placed on the top of the furnace and by operating the cables a "large pry bar" is forced into the brickwork, dislodging it. Besides decreasing tear-down time five days, we also realized a saving of approximately 2000 man-hours on this operation.

In order to supply our bricklayers, we have applied the pallet method for handling brick. Figure 2 shows a ramp built on flat cars, for moving from furnace to furnace, which gives access to the cast-house floor. The brick are palletized upon receipt and taken by the lift truck either to temporary storage on the cast-house floor, or directly into the furnace, as shown in Figure 3. A section of the lining at the tuyere level is temporarily left out to give lift trucks access to the interior of the furnace where it places the pallet load of brick in a cage for hoisting to the working platform. This change in method resulted in a reduction of 1300 man-hours per relining, and equally important, it brought about a material improvement in the condition of the brick. Less chipping and breaking of corners resulted from the reduced handlings in palletization.

Other methods are also used for supplying brick. Sometimes a temporary elevator shaft is used to raise the brick to the top of the furnace. This may be transferred from an outside to an inside elevator.

On a recent blast furnace repair it was necessary to lift pallets above the top of the furnace. Safety cages which fit over a pallet of brick were developed. These cages were assembled in groups of four, attached to a spreader beam, and lifted as a unit to the top of the furnace.

In order to eliminate a potential fire hazard, we have discontinued the use of timber scaffolding built in sections as the work progresses from the hearth of the furnace. By using the swinging scaffold shown in

Figure 1 — A mine loading machine is used in the removal of the stack lining.

Figure 2 — Motor trucks and pallets are used to remove the brick from the railroad car.

Figure 3 — When possible the brick is taken by the lift truck directly into the interior of the furnace.

Figures 4 and 5 we have cut out a 15 hours' delay for erecting and removing this scaffold, in addition to saving 400 carpenter man-hours and 13,000 board-feet of lumber.

Following the blow-down and the last cast, the molten iron still remaining in the hearth is tapped from as low a point as convenient to meet furnace conditions. However, a certain amount of this iron often remains. In order to clean out the hearth of the furnace it is necessary to remove this iron, generally referred to as "salamander." Formerly this was done by blasting with dynamite, which resulted in much confusion and loss

Figure 4 — View shows the under side of hanging scaffold.

of time prior to and immediately following each blast, when the men had to leave the job for a safe place. There was also the potential danger of unexploded dynamite remaining in some of the holes if all charges did not go off. Recently we have used a drop-ball weighing 10 tons for this purpose. This is lifted by means of a magnet attached to the hoisting rigging at the furnace top and, when dropped from heights varying from 35 to 70 ft, has broken salamanders varying from 4 to 6 ft thick.

In the "leveling-off" of the furnace bottom, a lot of cutting and fitting of brick is generally necessary. In order to decrease this we recently used a refractory gun mix material put in with a cement gun to "level off" the unevenness in the bottom. This material sets very hard and in relatively short time.

In order to eliminate the time required for cutting bottom blocks to meet the circumference of the cooling

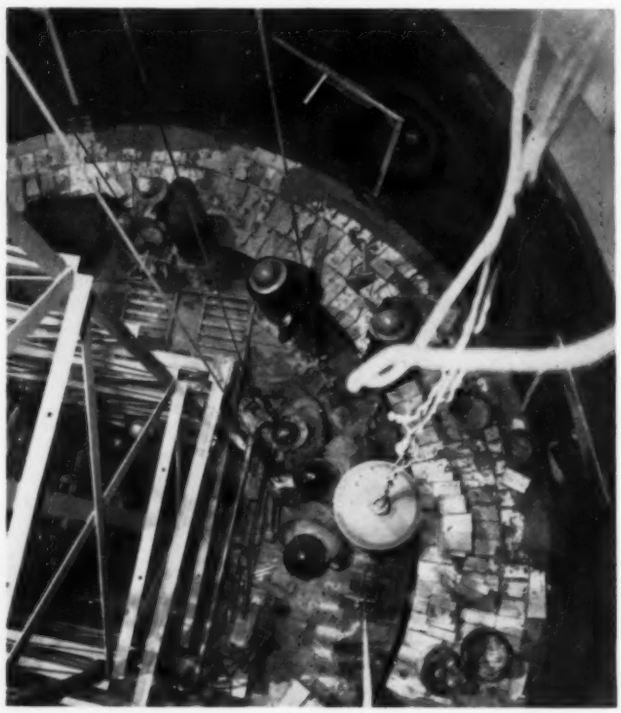


Figure 5 — The hanging scaffold is lowered and raised by means of wire ropes to the proper position for laying the brick.

plates, we now cut these brick ahead of time. We also cut brick for use under the tuyeres prior to the relining. This precutting saves approximately one day in the installing of brickwork.

When repairing hot-blast stoves, one of the main problems is the cleaning of checkers. Due to their construction, this operation is very laborious. As a means of expediting the job, we have applied the principle of sand blasting to clean the checkers while in place. This gives a much quicker job. Furthermore, when cleaning brick by hand there is always a thin film of soot left on the brickwork. By sand blasting the brick are made smoother and thus it will take longer time before any material starts to collect on the surface.

When it is necessary to replace the brickwork in the hot-blast stoves a large volume of brick is required. Due to the limited working space (Figure 6) ability to supply this brick as fast as needed is often a problem.

Figure 6 — View shows rolling conveyor leading to well of D furnace blast stoves.

A sling is used on which brick are placed and pushed into the well section of the stove for hoisting to the working level. The man-power required in this instance was reduced by approximately 25 per cent.

In order to decrease furnace down time, one of the easiest and shortest ways is to obtain efficient operation and coordination of the repair crews. Proper planning of the work, adequate safety precautions, provision of material, and adequate lights for night work, are of utmost importance. Not only will the down time of the furnace be reduced by taking these factors into consideration, but the cost of doing the job will also be decreased. With the return to competitive conditions, the lowest possible cost will again be paramount.

DISCUSSION

PRESENTED BY

H. R. KNUST, Assistant Superintendent, Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.

HUGO PHILLIPS, Engineer, Bethlehem Steel Co., Sparrows Point, Md.

T. A. LEWIS, Superintendent, Service Division, Bethlehem Steel Co., Bethlehem, Pa.

L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.

R. L. SEAY, Erector Foreman, Bethlehem Steel Co., Sparrows Point, Md.

M. F. REESE, Engineer, Bethlehem Steel Co., Sparrows Point, Md.

H. R. Knust: When you precut your hearth blocks to a given hearth diameter before the furnace is blown out, how do you insure that you get a good tight job when you lay them up? The hearth jacket is generally not perfectly round or plumb, and the hearth coolers are rough castings that when set inside of the hearth jacket form an irregular surface against which the hearth blocks must be tightly fit.

T. A. Lewis: Our experience has been that the hearth diameter varies very slightly. We will allow up to ¼-in. gap filled with clay between brick and hearth jacket. This takes care of unevenness and is not objectionable, as expansion of brick during heating up closes the void between brick and hearth jacket.

Hugo Phillips: In the use of the beam in knocking out the brickwork, tearing down the lining, what method do you use of eliminating the coolers before tearing down?

T. A. Lewis: We always pull coolers from outside the shell before tearing out lining. We use a yoke and jacking arrangement to loosen the coolers.

L. F. Coffin: Will you let us know what the means of access is to the stove? It looked as though the whole combustion chamber space would be occupied by the load of brick being hoisted up. How do the men get up into the stove to do the work?

T. A. Lewis: We send the brick in through the hot blast chamber, and the men use the same space to get into the stoves. The men do not use this entry when brick are being hoisted.

R. L. Seay: On the removal of the stack lining with the beam, is the stack lining removed from the bottom as fast as it is cut down, or is the operation of the mucking machine that you showed a mining operation? In other words, is that lining piled up on the inside, or does the machine move it as fast as it is cut down? Our problem in stack lining removal has been, not so much cutting it down, as removing it, from the hearth after it is cut down.

T. A. Lewis: On removing the lining from the furnace our experience has been that the mucking machine takes two shifts to remove what the beam tears down in one shift. After the beam has torn down quite a bit of the lining, it is possible with some protection at the top of the opening, to work the mucker and tear down lining at the same time.

M. F. Reese: When you showed us your mine undercutter removing the stock out of the furnace, you mentioned removing the stock and the old lining. Do you not segregate your stock and send it back to the blast furnace trestle, or do you junk the stock and lining together? Do you knock out the front of the hearth jacket before you strip out the lining and then let the whole business come at once? How about the stock or material below the tuyere level?

T. A. Lewis: The stock removed with the lining is only that portion remaining below the tuyeres. We salvage for recharging into the furnaces that portion of this stock which flows out upon opening up to provide access for the mucker. The balance of this stock is removed in conjunction with the lining and discarded. We do not consider it a safe operation to go inside the furnace until after the lining is torn down.

To provide access for the mucker, we remove the tap hole casting and brick lining at this section of the hearth.

MAINTENANCE OF OIL CIRCULATING SYSTEMS

. . . . maintenance of lubrication systems is dependent on the use of intelligent, trained personnel . . . .

By T. A. MARSHALL
Lubrication Engineer
Steel Co. of Canada, Ltd.
Hamilton, Ontario, Canada

▲ LUBRICATION has a long and interesting history. From the beginning of time, friction has been the greatest physical obstacle interposed between man and his dreams of an easier, and more productive way of life. With the invention of the steam engine, he was finally liberated from dependence on his own speed and endurance, or on that of animals and the sailing ship, at this point the hot and sticky fingers of friction asserted its tyranny. Fats and tallows, ineffective even in the crude wheels of the ancients, were futile expedients to relieve the tortured mechanisms.

We are all well aware that the reduction of friction by some means of lubrication has been an important part of the mechanical progress of our civilization. It has been less than a century since petroleum lubricants were placed at the disposal of industry and transport to prolong the life of machinery and increase production, but it is largely during the past thirty years that great strides have been made in improved mechanisms, and likewise, great progress in the art of reducing friction. As speeds and loads have increased, more and more attention has been given to the problems of lubrication.

The necessity for a proper lubrication program is now appreciated by the majority of industry, and the value of a well organized lubrication department, in relation to mechanical maintenance has been established, however in any lubrication program, means should be devised to simplify the work of the oiler as much as possible, and as oil is the most common and widely used lubricant this brings us to methods of application which range from the squirt can, through sight feed oil cup, to bath or splash, circulating bath, and finally the large circulating system supplying oil to a number of units from one central station.

In this paper we are concerned primarily with the circulating systems rather than the why and how phase of lubrication itself. So first let us visualize what is required for a system supplying oil to the back-up bearings of a modern hot or cold strip mil. The reason for selecting a back-up system is, it presents a cross section of the maintenance problems developed in all circulating systems whether large or small.

The supply of lubricant must be adequate, therefore the tanks should have a capacity of from 8,000 to 16,000 gallons, equipped with steam coils, thermometers, automatic temperature regulator, oil level indicator, heat exchanger and dual suction connections. Service and spare pumps must be available with motors of sufficient horsepower to insure the proper amount of oil at all times without overloading. A pressure tank and air supply lines are necessary, as well as a large capacity screen type filter capable of handling at least 250 gpm and equipped with cleaning alarm gong, differential pressure switch, and by-pass relief valve. The system must contain a pressure control relief valve together with pressure switches for low pressure alarm, in event of one pump failing the other will immediately go into service. As a further safeguard the feed lines to each mill are equipped with a pressure regulator valve to insure constant pressure to each bearing.

A system such as described is installed, with one thought in mind, to provide better lubrication. Mill superintendents, engineers and operators are highly desirous of maintaining high levels of production as well as eliminating costly delays and expensive repair caused by bearing failure. However, we still have the human element to deal with and after varying periods of operation, we find in many cases that unless a rigid inspection of these systems are maintained they could actually revert from an asset to a liability.

Many mills have resorted to some measure of inspection by millwright crews or by machine or pipe shop personnel. This is a step in the right direction, but in many cases proved inadequate inasmuch as the frequency of inspection was erratic and in some cases insufficient. Further a very considerable knowledge of the mechanics of operation of the various types of systems is necessary in order to ascertain the exact difficulty which was being experienced. Consequently, repairs were frequently beyond the ability of the mechanic or millwright to perform unless he was specifically trained for the job.

It is therefore, obvious, that in order to properly maintain a modern circulating system, a top calibre man is necessary to perform a top quality job. Pressure relief and regulator valves, can and do get out of adjustment, diaphragms in some instances have to be replaced, the man who makes the repairs must have a thorough knowledge of the operation of this equipment. Periodic cleaning of filters is another item which must not be left in the hands of the novice. He no doubt,

would in time be able to disassemble the filter, but the cleaning and reassembly is for the trained expert who is familiar with its operation. Automatic control instruments are delicate, as well as expensive, therefore it is imperative that their inspection be handled by a man trained for this work.

While pumps require a minimum of attention, like other types of equipment, they will wear to the extent that repairs are necessary. Regular pump inspections are a must, if failure at this point is to be avoided. This work cannot be entrusted to other than a trained expert on pumps.

The cooler must have attention at least once a year, waxy deposits from the oil will in time coat the copper tubes to an extent which will render it useless as a cooling medium, unless properly cleaned. This job does not require skilled labor, however, some know how is essential as any damage to the tubing will entail costly repairs.

Last but not least, receiving tanks have to be scheduled for cleaning, the frequency will depend on the type of equipment lubricated by the system. If water and scale contaminate the oil, the periods between cleaning will necessarily be shorter. Here the plant laboratory can be of material assistance in determining the condition of the oil.

No lubrication department or program will function smoothly and efficiently without this trained personnel available, who can effect repairs or adjustments intelligently and with a minimum of delay. This group of men sometimes referred to as inspectors, but more often as trouble shooters, should be known as the lubrication repair unit, equipped with specialized tools which are frequently needed, and suitable shop accommodations in which to make major repairs.

The returns from a program such as outlined will more than offset any liabilities incurred. Savings from decreased mill delays which include equipment repair expense, idle mill crew expense, and lost profit, when added to the savings obtained by decreased circulating oil system losses, increased reclamation, and general improved lubrication practice, will more than offset the expense incurred in maintaining the lubrication repair program in operation. In brief, the overall picture will show an improved condition of equipment conducive to reduce cost and more continuous production.

When management underwrites a lubrication program, they expect results, and these results will be in direct proportion to the efforts expended. If the maintenance superintendent is convinced of the value of well-organized lubrication, the mechanical and lubrication departments can operate in close co-operation and hold maintenance costs to the minimum, while at the same time extending the effective life of the equipment. Neither group can operate to full effectiveness alone, for the work of each reflects upon the other.

DISCUSSION

PRESENTED BY

GEORGE FINDLAY, Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio

E. H. GUYER, Electrical Superintendent, Wickwire-Spencer Steel Division, Colorado Fuel & Iron Corp., Buffalo, N. Y.

F. L. McCALLUM, Lubrication Engineer, Wickwire-Spencer Steel Division, Colorado Fuel & Iron Corp., Buffalo, N. Y.

T. A. MARSHALL, Lubrication Engineer, Steel Company of Canada, Ltd., Hamilton, Ont., Canada

George Findlay: I agree with the author that training men to install, maintain and service modern lubrication equipment is very important. I also believe lubrication engineers should sell the importance of lubrication to men and management more than has been done in the past.

E. H. Guyer: In line with what Mr. Findlay just said, we hire lubrication experts and pay them pretty fair money. I wonder if they should not handle the application of the lubricant, in other words, have the oilers under their jurisdiction.

F. L. McCallum: It is a well-known fact if you have a group of maintenance men applying your lubricants and something happens, they have to go to another part of the department and call help; in case of a breakdown, lubrication at certain points is neglected. We have found this to be true in our plant. All you other lubricating men have found the same thing in your plant. The application is a very, very important point. As Mr. Findlay remarked we do not have trouble with the proper lubricants. To me it is the men who can cause trouble. A great many of the men do not have the faintest conception what it means when you talk about viscosity and so forth. Those men should receive a course of instruction. They should be given the time to attend a meeting; say, in twos or threes, and have the fundamentals of the scope of lubrication; the whys and wherefores. They should have the various types of lubricants explained, why they are used and what the purpose is, and I really believe that it is the coming thing. A great many plants have adopted that procedure. If you have oilers under lubricating engineers direct, that is his job and it is up to the lubricating engineer to see he does it. If he does not, and there is a break-down he is on the spot, and as Mr. Marshall pointed out, on the inspection of temperature controls, pumps, pipe lines and the like, it really is a big thing. It pays off in the long run. I am all in favor of the suggested procedure.

T. A. Marshall: In my paper I did not wish to lend the impression we had reached the acme of perfection in the lubrication department, but enlarging on what Mr. Findlay and Mr. McCallum has said, the lubrication department in our company is an integral part of the mechanical department, and we have the backing of the mechanical superintendent and his assistant. We work directly through millwright foremen. The lead oilers are millwrights, and we are training other millwrights to be oilers. We are taking a long step, but I hope to see the day when millwrights will seek oiler jobs instead of having to move men up from sweepers. A good oiler must have some mechanical ability and knowledge of the machinery he is lubricating before he is capable of intelligently applying lubricants.

SPRAY LUBRICATION OF OPEN GEARING

. . . . fluid type spray lubricants have a number of advantages over the old type which had to be heated . . . .

By F. L. McCALLUM
Lubrication Engineer
Wickwire-Spencer Steel Div.
The Colorado Fuel and Iron Corp.
Buffalo, N. Y.

▲ THE convenience of application and a consistency that permits a lubricant to stay in position, definitely affects the choice of the type of lubricant suitable for use on all types of open gears, both in buildings and out of doors, and for lubrication of wire ropes and cables used on cranes, dredges, mines, etc., applied either manually or by using an air-operated spray gun.

The type of lubricant, suitable for spray gun application, must not be affected by water, either acid or alkaline. They should have their naturally high pressure-resisting ability increased by the use or addition of additives because of microscopic film thickness.

In order to prevent metal to metal contact between gear teeth, an efficient oil wedge is required in the area of contact. The character of the lubricant used has a major effect in establishing and maintaining this wedge.

On spur, helical, herringbone, bevel and spiral-bevel-gear teeth, the line of contact between engaging teeth sweeps swiftly without side slide over the entire working surface of each tooth; hence contact at any specific point endures for only an instant. Pressure, therefore at such a point is applied and released so quickly that there is comparatively little time to squeeze out the fluid film of the lubricant. Moreover, the direction of sweep in relation to the line of contact acts to create an oil wedge. If an effective wedge is to be formed, it is important that the material be of proper body or viscosity.

Under conditions of boundary lubrication, the characteristics of a gear lubricant are of special importance, for when films are only of microscopic thickness, it is the composition and quality of a gear lubricant that determines whether it will provide the necessary lubrication to prevent excessive tooth wear.

When a lubricant is first applied to an open gear, centrifugal force tends to throw it off the teeth, this is particularly noticeable when the lubricant is poured on gears which are running, therefore, if the body of the lubricant is too light, it will not remain where needed. Moreover light bodied lubricants, made so by the use of diluents, are more easily squeezed from between the teeth, hence, permitting the oil film to reach more rapidly the condition when boundary lubrication occurs. Thus, to minimize throw-off and to extend the period before boundary lubrication takes place, careful consideration should be given to amount or per cent of diluent incorporated into the original base of the lubricant in order to make it fluid or suitable for spray gun application.

Because open gears operate much of the time with only microscopically thin films, a lubricant, i.e., the base lubricant, is required that possesses a combination of maximum resistance to being wiped off the gear-tooth surface, and high film strength. These two characteristics depend jointly on oil body and oil character. Heavier bases naturally contain heavier petroleum hydrocarbons which usually bond more tenaciously with metals, and form boundary films that are stronger and more difficult to remove. Persistence-of-film also depends on the crudes from which an oil is made, and upon the methods which are employed in refining those crudes. Certain lubricants, of the type being discussed, because of the crudes and special refining methods, possess this persistence-of-film characteristic to an unusually high degree.

However, most of the foregoing should be considered when we are using an open gear lubricant that has to be heated in order to apply manually.

Just what effect the addition of diluents have during the period, just after application, until complete evaporation takes place has not been definitely established. Some suppliers of this material claim the diluent will evaporate in from five to eight minutes, and some in less time.

Open gear fluid lubricants have been rendered fluid by the addition of a volatile, but non-inflammable diluent. Heating, therefore is not necessary in order to apply these products either by hand, or by means of devices such as drop-feed oilers, mechanical forced-feed lubricators or spray guns. The volatile diluent evaporates after the lubricant is applied, leaving a heavy, tacky, adhesive coating of lubricant on the teeth.

As regards the type of spray gun suitable for the application of the fluid type gear lubricants, now available, there seems to be many and varied opinions.

After testing various types of spray guns and materials, some interesting information was obtained. It might be well to state at this point that data on equipment available and type or types of lubricant are still under investigation. It might be of interest to state some of the points on spraying that have been observed.

In the beginning, an ordinary paint spray gun was used, here it was found that the nozzle was not rugged enough to withstand the usage around a rolling mill, there were too many parts, and air pressure was too low, and unless the nozzle was thoroughly cleaned after use it soon failed to operate.

Further it was found that a longer nozzle or orifice tube was desirable from a safety standpoint in order to place more distance between the operator and the gears, and at the same time bring the mist or atomized lubricant into narrow focus, thus minimizing the amount of material required for an adequate covering of the gear teeth.

An adjustable nozzle is necessary as temperature affects the viscosity or body of the material, and once the proper orifice opening has been established, for any

given material, the viscosity of the material should remain constant. Therefore adjustment is necessary in order to obtain a uniform pattern to compensate for change in viscosity due to temperature.

Types of spray guns that obtain the lubricant by creating a suction on the container are not satisfactory due to the temperature effect on viscosity. The spray gun that forces the lubricant out of an orifice does not give a constant spray pattern, also air pressure is too low. Tests have shown, up to this point, that the most suitable type of spray gun is a combination type in which the lubricant is fed to the spray nozzle under at least 90 to 100 psi air pressure, which in turn is atomized by an independent or secondary air jet of the same pressure. The nozzle is so designed that the lubricant which is forced to the orifice in a semi-atomized state is picked up by this secondary air jet, receives complete atomization and is forced through the orifice or nozzle. Both the primary or air and material jet, and the secondary or air jet, must flow in a parallel direction. Adjustment is made on the secondary jet only, and the tubes are self cleaning with air.

The nozzle tube should be at least 24 in. long, connected to the container by rubber tubing. A very handy container of approximately 4 to 6 quarts capacity was used in tests, this container was equipped with thumb button controls for both the primary and secondary jets. It was surprising the number of gears that this amount of material will cover if properly applied.

The next point to consider should be the supply of lubricant to the spray gun, location of stations, etc. Some plants have run pipe lines direct to the drum of lubricant from the various station locations. Others place the pump on the drum, at a central point, and run hose lines to the spray gun in order to obtain mobility. All of these installations have their objections. Pipe lines for the lubricant are subject to breakage, the use of long hose lines are cumbersome and subject to damage, as well as temperature changes.

A simple set-up would be to run air lines to the various points or stations. The spray gun assembly may be equipped with about 10 ft of air hose from air line stations spaced approximately every 20 ft. All air stations are equipped with quick detachable air couplers. The operator re-fills the container in the oil room, where in winter the lubricant is kept warm, and returns to whichever station is necessary. This equipment is light, very mobile and easy to operate.

It might also be of interest to point out that the use of the old type of gear lubricant which required heating has been discontinued at Wickwire Spencer Steel Corp., and all open gearing in the plant is lubricated with the fluid type material. Further the use of this type of material reduces consumption, has a tendency to keep the plant clean and is much easier to handle. However as far as the equipment is concerned, a great deal of research is required before definite standards as to what constitutes an all-around spray gun are established. In this case the opinion may be stated to the effect that the oil companies have produced a product in advance of efficient equipment for its application.

Very recently, some new items have developed. In rod mill drives we have found that where the speed of the gears is high, after a period of time the noise factor becomes very obvious. Here we went back to some of the old type gear lubricant which we had to heat and it quieted down. However, there was no noticeable wear in the gears. Notwithstanding, I want to point out this that this new type gear lubricant is the coming thing. I understand a firm is making up a special gun for this. After it is made up we want to see what it will do. There is a lot of exploratory work to be done yet. The oil companies are cooperating to their fullest extent, and there are only a few of the major oil companies that have a product of this kind.

DISCUSSION

PRESENTED BY

ROBERT KOTTMEIER, Technical Representative, Canadian Liquid Aire Co., Ltd., Hamilton, Ont., Canada

F. L. McCALLUM, Lubrication Engineer, Wickwire-Spencer Steel Division, Colorado Fuel & Iron Corp., Buffalo, N. Y.

ARTHUR R. KINNEY, Director of Purchases, Wickwire-Spencer Steel Division, Colorado Fuel & Iron Corp., Buffalo, N. Y.

W. R. VAN NOSTRAND, JR., Sales Engineer, Tool Steel Gear & Pinion Co., Kenmore, N. Y.

R. Kottmeier: I would like to add as a suggestion the use of compressed nitrogen in cylinders. Three thoughts come to my mind: first, the fire hazard likely with the air — oil mixture could be eliminated by the nitrogen — oil mixture. Secondly, it is a nuisance to connect to plant compressed air lines in many cases. With the cylinder nitrogen, the outfit would be portable. Thirdly, cylinder nitrogen is normally dry and the slugs of water usually present in plant air lines would be eliminated. What are your thoughts on this?

F. L. McCallum: In my opinion based or formed from what I tried, you cannot effectively apply these new type of lubricants without air pressure. I grant you there is a certain amount of moisture. It has been suggested to me that you should have a water trap in the line, but my experience so far has been that most of the gears were not near open flame or anything like that, and my own personal opinion is I do not think I would worry too much about that.

Arthur R. Kinney: Have they ever tried water as a lubricant on these open gears?

F. L. McCallum: I have used water on main bearings. It is used on propeller shaft bearings on ships. Water is one of the finest lubricants if you can get it to stick in there, but on open bearing, no.

W. R. Van Nostrand, Jr.: I am not a lubrication man, but I know that the Crucible steel people down in Syracuse are using water on babbitt bearings in one of their mill pinion stands.

Arthur R. Kinney: I was referring to open gears. You said contact is only for a remote fraction of a second. It seems to me water constantly circulating should serve the same purpose.

F. L. McCallum: I would not think so. The reason why we add these base lubricants is to give it density of film. It is just that it sticks. Water would not do it. In high-speed gears it is all right under certain conditions and light load. However, I do not recommend it.

EMERGENCY REBUILDING OF HOT METAL CHARGING CRANE

By A. D. HOWRY
Alan Wood Steel Co.
Conshohocken, Pa.

. . . . fast action was required to restore this hot metal crane to service after a bad accident . . . . quick thinking and a well planned program reduced crane down time . . . .

▲ STEEL plant maintenance, preventive, projected or emergency can and does provide the most interesting occupation in the entire industry. The most carefully planned and scheduled project of rehabilitation can in a moment revert into an emergency, an emergency in which plans are waived aside and on the spot decisions and commitments are made and kept.

Such was the case on Friday evening, October 15, 1948.

Prior to this date it became increasingly evident that our one and only hot metal charging crane, fondly or otherwise known as the "Battleship" must have some major repairs and rebuilding done to the trucks and crane structure.

This crane, with a span of 62 ft, of double box girder construction, carried on four two-wheel trucks, with main and auxiliary trolleys and hoists of 70-ton and 30-ton capacity; had, due to the continuous service of the war and post war years, shown evidence of misalinement and wear of major parts.

A careful survey disclosed that the two wheel pony trucks, the 6-in. swivel pins, and bushings were badly worn, allowing the bridge to weave endways. This weaving put undue strain on the structural members tying in the box girders to the high end trucks, popping rivets and developing strain cracks.

It was agreed by management, that a new end pony truck should be fabricated from welded plate construction, upon completion to be installed on one corner, boring out the king pin bushings to suit, then repeating until all four corners were complete. The bridge structure was then to be squared up and reriveted, after which the line shafting, trolleys, etc., were to be overhauled. It was evident that a multitude of spot outages were in store, but there was no way out, the work had to be done.

Consequently, the end truck was drawn up and ordered, spare parts were checked and orders placed for replacement of parts to be used.

This was the status of the projected repair job on that Friday evening, when just before leaving "the phone rang," and the open hearth superintendent informed us "we just dropped a ladle from the battleship." After rushing down, we noted that the half full ladle was upright, no metal spilled, no one hurt. We observed, however, with amazement the damage done to the lifting mechanism by the ladle dropping uncontrolled for the short distance of approximately five feet. A quick check showed that the projected repairs did not contribute to the mishap.

Investigation later, disclosed that the approximately 45 tons of molten metal and ladle were descending at an abnormal rate, the operator attempted to plug with no response and cut the main power. The ladle hit the floor with such force it bounced, meeting the spreader bar coming down and threw it up against the girders. Suddenly the main and auxiliary brakes applied, the spinning drums ripped out ring gear teeth, bent the 6½-in. third shafts and second shafts, popped 1-in. bearing cap bolts and sundry other damage.

It is always difficult to determine, in a case such as this, just what caused the failure, but a ground located in the resistance bank could have neutralized the dynamic braking effect and held the series brakes open.

We were down, with a half filled ladle stranded at a critical point on the charger floor, a bottle of hot metal in the mixer house, and the closest cold iron at the blast furnace. We move fast at a time like this, the general superintendent was called, likewise the maintenance engineer, emergency crews were alerted, the stranded ladle was carefully slung, lifted with the 30-ton auxiliary hoist and placed on a ladle car, the disabled crane moved so that charging could proceed, and the maintenance crews immediately proceeded to remove the damaged parts.

Now the problem was: Should we proceed to make emergency repairs and replace the damaged parts, possibly taking three days, with the overall rehabilitation job still ahead of us; or, should we proceed immediately with a complete rebuild job? After a spot

conference the maintenance engineer and general superintendent contacted the executive vice president, suggested that we move in and complete both the entire emergency and projected jobs. A time commitment of ten days was made, service was set for 4:00 pm October 26 at an estimated cost of $14,000. This was approved and we had a job on our hands.

The crane was stripped for action, procedure was set up, outside contracts were let in hours to rebore the pony truck, king pin bushings and aline the bridge, replace rivets, etc. The auxiliary trolley was removed complete, and sent to the maintenance shop for a complete rebuild job, end pony trucks were removed one at a time, sent to shop, rebuilt and replaced, all worn wheels, gears, bearings, sheaves, etc. were replaced, shop orders were placed (26 all told) too varied to enumerate.

Within 24 hours of the breakdown, the job was organized and running smoothly, from then on in it was a matter of time. Millwrights, motor inspectors, riggers, electricians, lubrication men and outside contract men all worked long hours together.

The order for a spare two wheel pony truck was cancelled, as we now had sufficient time to shop and rebuild each individual truck. We were thankful that foresight had provided the spare parts we needed so badly, the few parts not on hand we fabricated in our shop, worn bearing seats were built up, rebored and realined.

Motors were shopped for reconditioning, controls were rebuilt and relocated, a shoe-type brake was built from spare parts, replacing the obsolete type band brake on the auxiliary hoist. A complete new centralized pressure system was installed on both trolleys, hoists and bridge.

It may appear, that after organization, the rebuild job was more or less routine. This was not the case. This hot metal crane is on the same runway as our three furnace charging cranes, no matter where we spotted it, there was interference with charging floor operations, the work on the pony truck had to be done under difficulties. On the outside, the work had to be done through the lattice supporting structure of the building. On the pit side it was the big ladle cranes that presented not only an obstruction, but a definite hazard that we had to be on the lookout for at all times.

The open hearth superintendent had his eye on us at all times. Tuesday morning on the 10th day, he was anxious to go. He ordered his hot metal and at 4:00 pm the ladle of metal was coming up the floor, but we took an additional 15 minutes for final adjustments of brakes, control, etc.

The men went home with the feeling of a job well done, the supervisory force was pleased that we held the time and cost to the "on the spot" commitment, and management was satisfied that we again had a dependable piece of critical equipment.

DISCUSSION

PRESENTED BY

HARRY H. ANGEL, Electrical Engineer, Construction and Engineering Department, Bethlehem Steel Co., Bethlehem, Pa.

A. D. HOWRY, Alan Wood Steel Co., Conshohocken, Pa.

M. F. REESE, Engineer, Bethlehem Steel Co., Sparrows Point, Md.

JOHN W. DEIMLER, Electrical Engineer, Alan Wood Steel Co., Conshohocken, Pa.

H. H. Angel: I would like to ask Mr. Howry — it really was not made clear to me, as to what caused the ladle to get away in the first place.

A. D. Howry: I believe you men, familiar with steel plant maintenance, possibly can give the answer as well as I. When something like this happens, there is always a lot of guess work. Sometimes we have a tendency to place the blame on the operator: "The operator slipped up," or, "It is a slip of manpower," of course they do not agree.

The actual cause of the failure is at best a good guess, subsequent tests developed a ground on the hoist dynamic braking resistor, this, together with the fact that the operator tripped the main crane protective breaker may have nulified the dynamic braking effect and held the series shoe brake open.

M. F. Reese: When you rebuilt the crane, did you replace the cover plates and in what condition did you find the diaphragms in the box girders? If you found them worn how do you go about repairing the diaphragms? Also, after taking this crane out of service so abruptly what condition did you find the end-fastenings of the main and auxiliary girders to the trucks, for example?

A. D. Howry: Mr. Reese, asked if we replaced the top plates on the girders. We did not. They were in relatively good condition. We did replace the rails. They were worn down in spots, particularly at the end where they plugged the controls. The box girder is set on top of the underframe with a 45 degree brace. Due to the fact of the worn pony trucks weaving back and forth, these 45 degree brace members were overstressed, the rivets popped out here and there and caused cracks in some plates large enough to get your hand between. Inspections of the girders themselves, showed no indication of failure. We have inspection ports in the girder, and a man small enough can get from one end to the other.

John W. Deimler: I think that the possible cause, as near as anyone can tell, was analyzed properly. That is, the dynamic breaking circuit was grounded, and the series brakes were held open. When the operator cut off the main power, the brakes applied. They were new magnet shoe brakes in good adjustment, so when they applied something had to let go. That is when the damage to the gearing and line shafting occurred.

Member: I wondered if you had a true overspeed condition in which the ladle made the motor overspeed due to some control trouble. Of course it is pretty hard to find after it is over.

A. D. Howry: We did find a ground on the dynamic braking circuit. The ground was of such condition that in trying to reconstruct a circuit there was a possibility that with the dynamic braking circuit through the ground, the current went through the brake and held the mechanical brake open. That is as close as I can come to it.

REPAIRS TO HEAVY CASTINGS

. . . . the metal insert method of repairing castings can sometimes put back into service broken equipment which cannot be practically repaired by other means . . . .

By G. O. VAN ARTSDALEN
Superintendent of Maintenance
Henry Disston & Sons, Inc.
Philadelphia, Pa.

▲ THE cold method of making repairs to broken machine sections has proven very successful and economical in recent years. It has expedited the return of machinery to useful service after a breakdown, and in many cases has caused the broken parts to have greater strength than was possible before the break.

This method has been applied to the repairs of cast iron machine parts, usually of large size, making repairs possible with little or no dismantling. It is not confined to large machinery; however, being used frequently to quickly repair production equipment after a smashup, and making it possible to put presses, shears and other types of machinery back into production with a minimum of down time.

Frequently these repairs can be made in a matter of hours when to supply new parts may take days or weeks, depending upon the amount of machine work required. Most of you are familiar with the problems encountered in making repairs to cast iron by welding. Even with the greatest of care exercised, distortion frequently occurs resulting in remachining and frequently an unsatisfactory fit-up at assembly. Larger castings that cannot be preheated due to their size have been repaired in the past by studding and lace welding with indifferent success. Large machine frame sections of cast iron having large surface areas with comparatively light cross section area cannot be welded at all but must be replaced. Many times bronze weld metal is used for joining broken castings because of the lower temperatures required for fusion, thereby lessening the danger of distortion. This practice has helped make repairs in many instances when the most important factor was to seal a leak rather than to impart strength comparable to that of the original sound casting.

Figure 1 — Repairs were made to this 20-in. hand sheet mill housing, with tie bolts.

The locked metal process can be used for making repairs in cast iron where it is impractical or impossible to weld. The basic lock consists of a forged bar of high strength steel which is crimped at regular intervals so that it has the appearance of a number of cylinders joined by straight sections of uniform length. The shear resistance or holding strength depends upon the number of cylinders anchored in each side of the fracture. The recesses are prepared to receive the locks by drilling a series of holes equal to the number of cylinders on the lock used. These holes are accurately spaced with a template designed to leave a web approximately ¼ of the diameter of the hole between the holes. This web is removed by cutting between the holes with an air hammer and chisel. The lock inserts are driven into the voided area with the air hammer and peening tool. Continual peening on each lock greatly improves the fit, at the same time greatly increasing the lock strength.

Successive locks are worked into the drilled-out area until the area is filled. These locks are usually ¼ in. thick and the holes are drilled deep enough to permit the addition of sufficient lock sections so that their combined tensile strength should be at least 25 per cent greater than that of the casting. After all locks have been installed, the crack itself is filled with threaded studs usually called the lace. This lacing is upset by cold working in the same manner as the locks, and serves to give a continuous line of repair metal making it pressure tight as well as preventing longitudinal stresses from shearing the locks.

A variation employed widely in repairs to heavier castings with greater cross section areas uses high tensile steel bars inlaid across the break, imparting considerably more strength than would be possible with the inlay alone.

Large slabs are prepared by shaping semi-cylindrical notches around their periphery to match the standard template used in a repair. Matching half holes are then drilled into the casting to the depth of the plate thick-

Figure 2 — This 20-in. cold reduction mill housing was repaired by the metal insert method.

ness and all metal removed between them. The matched half holes are then reamed to form a true hole to receive the lock material. This is in the form of dowels, being driven in with a power tool and cold worked as previously described.

This second method has the advantage over the plain metalock in that it permits the locking to be distributed over a wider area, and imparts in most instances greater strength than existed before the break.

It should be mentioned here that the success of repairs by the methods just described depends greatly upon the skill and accuracy of the mechanic as well as the proper use of cold working of the added metal.

It is generally known that the tensile strength of all common metals is greatly increased by cold working.

Figure 3 — Note similarity of repair to ordinary stitching. Repair was made on high pressure cylinder casting of 750-hp cross-compound steam engine.

Close tolerances are adhered to in the drilling and plugging operations. Air tools are used almost exclusively because of their lighter weight and small size for a given capacity.

DISCUSSION

PRESENTED BY

L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Co., Sparrows Point, Baltimore, Md.

J. A. BELL, Chief Engineer, Bethlehem Steel Co., Bethlehem, Pa.

G. O. VAN ARTSDALEN, Superintendent of Maintenance, Henry Disston & Sons, Inc., Philadelphia, Pa.

L. F. Coffin: I think it ought to be brought out that this method does not give a permanent repair in every case. While the method may be a permanent repair for a crack caused by an unusual accident nevertheless on a part that is under severe repeated stress (due to the fact that the lock does its work over a much smaller area of the cast iron) there is a tendency for it in time to loosen up and fail.

J. A. Bell: I would like to say one thing regarding the method, that has to be taken into consideration — that is, the limit of thickness that can be handled by the process. I would like to ask Mr. Van Artsdalen if he has had any experience with thicknesses up to 12 inches, and if anyone has ever done a job of that magnitude. The reason I mention this is that we had a 134-in. mold and in pouring the ingot, the mold cracked — the mold was about 21 inches thick, and the question was raised as to whether or not it could be repaired. I did not think it could be, and we still do not have the answer as to whether it can be done or not. Since there must be a limit as to what you can repair by the method, I am wondering if Mr. Van Artsdalen can answer that question.

L. F. Coffin: Let me give one answer. At the Johnstown plant there was a blooming mill crank shaft 24 in. in diameter and they put the two edges together, installed the inserts, and it ran for a number of months.

J. A. Bell: Was that steel?

L. F. Coffin: Yes.

G. O. Van Artsdalen: One thing I wish to point out is that the work must be done by the mechanics of the company which holds the patents.

Mr. Coffin has already said, and rightfully so, that it cannot be considered as a permanent repair for years to come, but it has helped us and many others, in several instances, to get out of a jam where we had no spare housings and we had to get going in a hurry.

A 20-in. hand sheet mill repair was made about a year ago and an 18-in. hand sheet mill repair is probably nine months old. I expect, since there was no complete fracture or severance of the two parts of the engine cylinder, to leave that stay as a permanent job, unless the fracture continues across the cylinder and separates the two parts.

Mr. Bell asked the question as to the limit of thickness. As I said in the beginning, we are a very small steel mill. Our housings are toys compared to some at Bethlehem and Lukens. We have not gone over a size of 12 by 18 in. cross section so I cannot answer for repairing a large housing.

THE MAINTENANCE OF HYDRAULIC VALVES

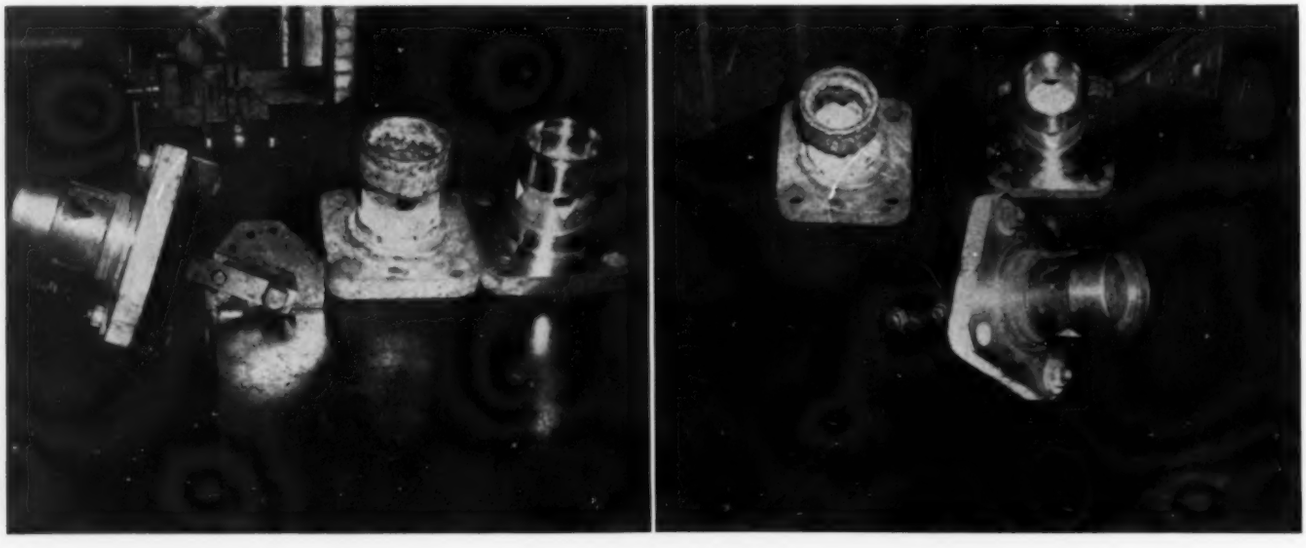
By JOHN H. DOTTER
General Millwright Foreman
Plate Mills
Bethlehem Steel Co.
Sparrows Point, Md.

. . . . successful operation of hydraulic valves depends upon an adequate set of tools and jigs, spare parts and well trained mechanics . . . .

▲ THIS paper is devoted entirely to the care and maintenance of hydraulic operating valves, and makes no attempt to deal with the various aspects of valve design. The hydraulic operating valve is a very important and essential piece of mechanical equipment, and great consideration and care must be given to its maintenance. A complete record should be kept on each individual valve, showing location, time in and out of service, repairs made and parts used. This record is necessary in order to determine the efficiency of the various valves.

Sufficient spare parts must be carried on hand, and each part should be carefully checked when received, in order to make sure that it is of proper quality and that it will fit the valves for which it is intended. A poorly fitting part may be the source of considerable delay in operation. Up-to-date catalogs and prints on hydraulic

Figure 1 — Jigs are valuable in valve maintenance.



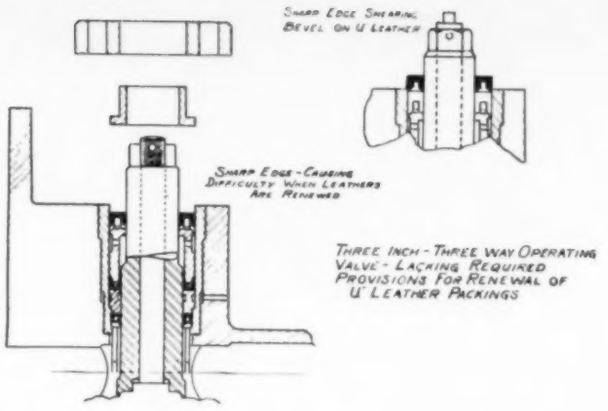
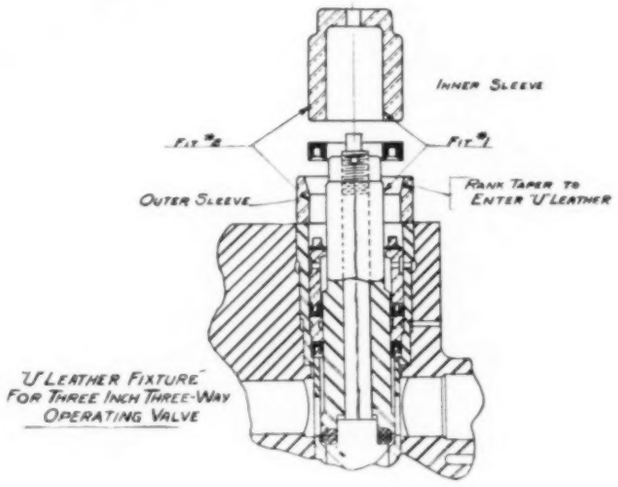

Sharp Edge Shearing Bevel on U Leather
Sharp Edge - Causing Difficulty When Leathers Are Renewed
Three Inch - Three Way Operating Valve - Lacking Required Provisions For Renewal of U Leather Packings

Figure 2 — Packings should be so designed that they are easily removable.

Figure 3 — This valve is so designed that the packing can be easily replaced.



valves and spare parts should always be on hand for ready reference.

In addition to an adequate supply of spare parts, a complete set of tools, jigs, and fixtures must be available. These include reseating tools, guide sleeves for placing packing, and jigs for making valve repairs.

One example of such a jig is shown on Figure 1. Here the basket head of a 4-in. operating valve is mounted in such a manner that the welder is able to work continuously while making repairs, without interruptions for resetting the job. When a piece is set on this fixture it can be turned at will as the work advances.

The selection of suitable packings to be used is also essential, as these can be a source of great annoyance. Not only must we consider the labor and expense of renewals due to packing failure, but we must recognize the high cost of unexpected shut-downs.

The simplicity of the packings themselves may invite negligence, but more often there is failure to recognize certain principles in design, such as shown in Figure 2. In this illustration a section of a 3-in., three-way operating valve is shown. In the design of this particular valve, the manufacturer evidently gave no thought to the replacement of packings. The bushing in the top of this valve is straight, without any provisions for entering the "U"-type packing required to hold the valve shut. If care is not taken, the repairman, in replacing the packing, will invariably cut a bevel on the outside of it, as shown along side the section of valve. This not only destroys the packing, but it also reduces the operating efficiency of the valve, as water will leak past the packing and cause slow operation. In order to prevent such workmanship, a fixture can be made so that the packing may be easily replaced without being distorted or destroyed. As shown in Figure 3, this fixture is made in two pieces consisting of two brass sleeves, one inserted in the other. The inside diameter of the outer sleeve is a fraction smaller than the bushing bore in which the "U" leather is to be installed. This sleeve should have a rank taper on the lead end, to permit the "U" leather to enter with ease. Fit No. 1 at the valve stem is used as a positive guide to center this fixture, while fit No. 2 serves to hold the outer sleeve in position to guide the leather in place. All sharp edges on the fixture should be relieved. After the leather has been placed in position, the inner sleeve is inserted into the outer sleeve, on top of the leather, and tapped lightly. This in turn pushes the leather to its proper position at the top of the valve, undamaged.

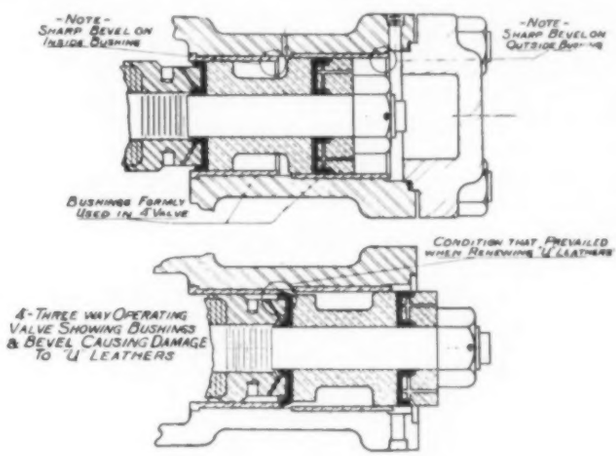
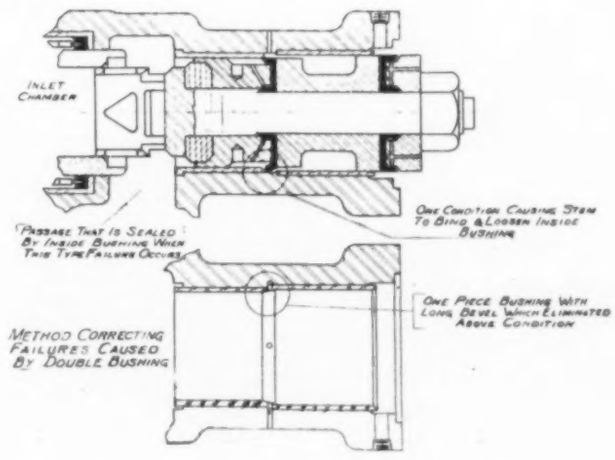

-Note- Sharp Bevel on Inside Bushing
-Note- Sharp Bevel on Outside Bushing
Bushings Formly Used In 4" Valve
Condition That Prevailed When Renewing U Leathers
4-Three way Operating Valve Showing Bushings & Bevel Causing Damage To U Leathers

Figure 4 — Section of a 4-in., three-way operating valve shows the stem and leather packing in place.

Figure 5 — The stem must be driven straight in order to avoid later troubles.


Inlet Chamber
One Condition Causing Stem To Bind & Loosen Inside Bushing
Passage That Is Sealed By Inside Bushing When This Type Failure Occurs
One Piece Bushing With Long Bevel Which Eliminated Above Condition
Method Correcting Failures Caused By Double Bushing

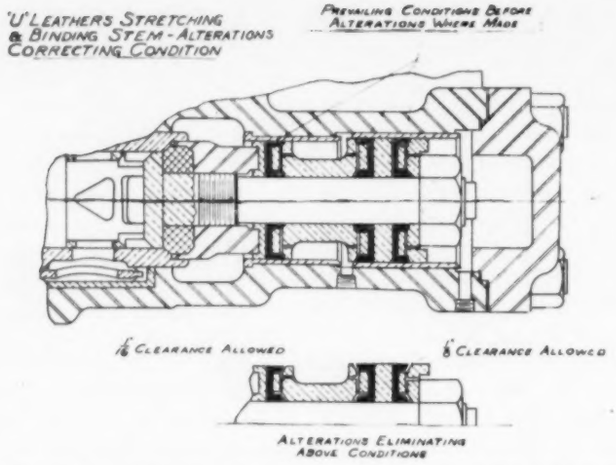

'U' Leathers Stretching & Binding Stem - Alterations Correcting Condition
Prevailing Conditions Before Alterations Where Made
1/16 Clearance Allowed
1/8 Clearance Allowed
Alterations Eliminating Above Conditions

Figure 6 — The sketch shows alterations which will help eliminate binding of the valve stem.

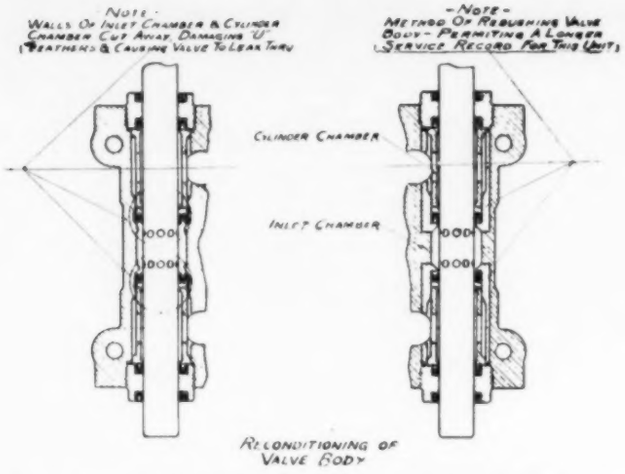

- Note -
Walls Of Inlet Chamber & Cylinder Chamber Cut Away, Damaging 'U' Leathers & Causing Valve To Leak Thru
- Note -
Method Of Rebushing Valve Body - Permitting A Longer Service Record For This Unit
Cylinder Chamber
Inlet Chamber
Reconditioning Of Valve Body

Figure 8 — Service life of valves can be extended by rebushing chamber walls.

Figure 4 is a section of a 4-in., three-way operating valve showing the stem and leather packing in place. It has a two-piece bushing on the high-pressure side of the valve body and a short, sharp bevel on the ends of each bushing. These bevels were intended to permit the leather packing to enter the valve without difficulty. through a period of maintaining this valve, it was discovered that in replacing these "U" leather packings, the repairman would use a block of wood and a light maul to drive the stem through to its proper position. In doing this he would destroy or cut the most important and effective portion of the "U" leather packing on the sharp bevel of the inside bushing.

Another difficulty encountered because of this two-piece bushing is shown in Figure 5. The repairman in driving the valve stem in place, may fail to keep it perfectly straight, causing it to bind and loosen the bushing. The pressure would then leak by the worn or damaged "U" leather, get in back of the bushing, and cause it to move. This would block the outlet passage and prevent the operation of the valve. With this type of a failure it becomes necessary to remove the valve, which results in an appreciable delay in the operation, at considerable cost. By replacing these two bushings with a one-piece bushing containing a longer or larger bevel, we were able to prevent both the destruction of the "U" leathers and the loosening of the back bushing.

Figure 6 illustrated another problem with the "U" leather packings stretching and binding the operating valve stem in the bushings. This was eliminated by machining the inner retainer or spacer back further, as shown. We could then be sure that the leather had sufficient room to stretch without lapping over the edge of the retainer.

In connection with Figure 7, the importance of leather packings should again be emphasized. All leather packings should be carefully inspected when received, not only for quantity and quality, but for proper form and size. A very slight variation in the forming of leathers can cause a considerable delay in operation and an excessive maintenance cost. With one example in mind, refer to a $5\frac{3}{4} \times 7$-in. "U" leather shown in this illustration. This leather is used for the high-pressure head of a 4-in., three-way operating valve. The "U" leather packing sealing this particular basket head must be formed for three fits. If there is any variation from the original form it will be a constant source of trouble, due to one or two of the improper fits causing the inside diameter of the leather to collapse. When the basket on the high-pressure head is started through this leather, in this distorted condition, it will turn the inner

Figure 7 — Leather packing must be properly formed if trouble is to be prevented.

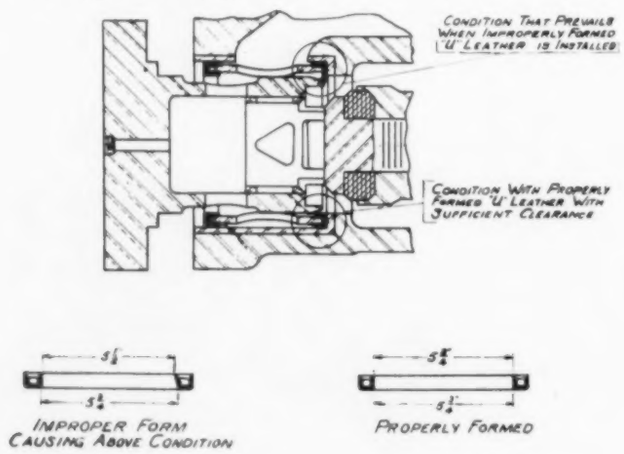
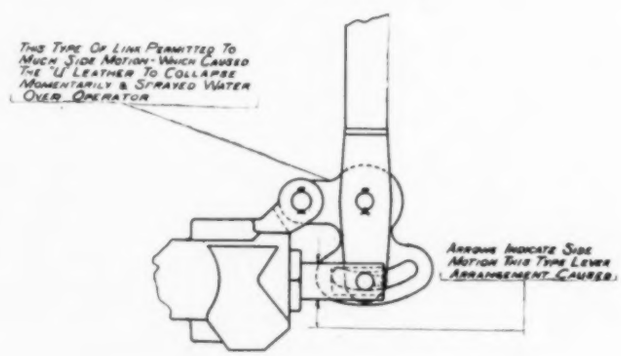
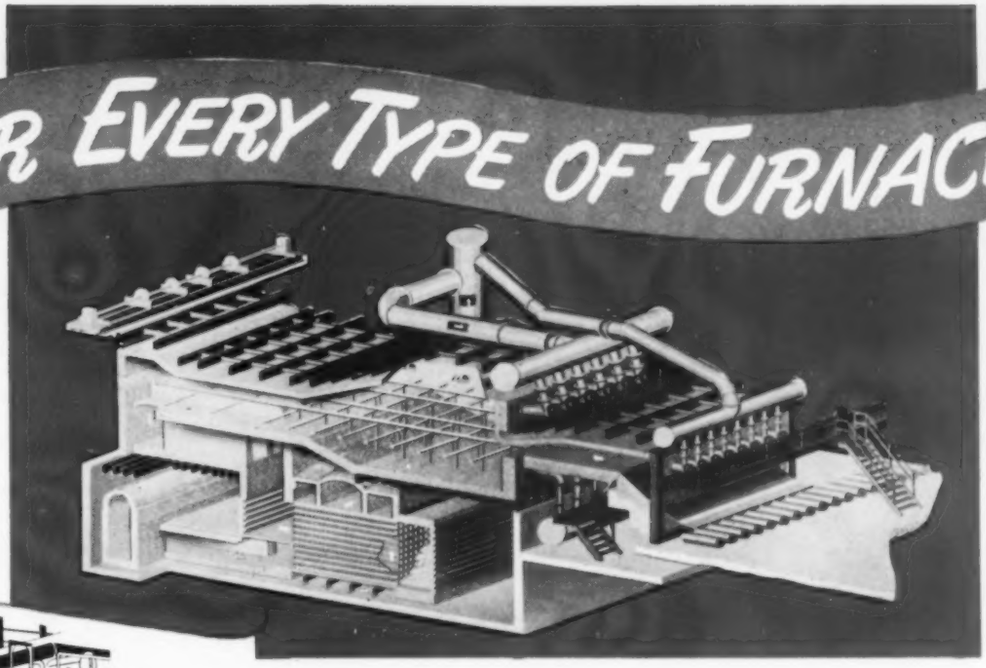
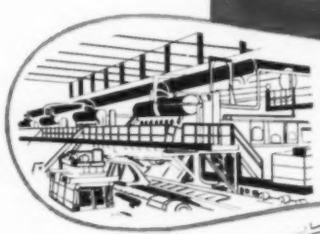

Condition That Prevails When Improperly Formed 'U' Leather Is Installed
Condition With Properly Formed 'U' Leather With Sufficient Clearance
Improper Form Causing Above Condition
Properly Formed

Figure 9 — Lever arrangement may sometimes cause unsatisfactory operation of the valves.

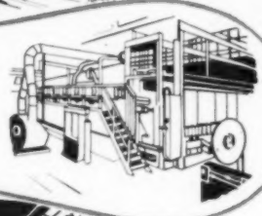

This Type Of Link Permitted To Much Side Motion - Which Caused The 'U' Leather To Collapse Momentarily & Sprayed Water Over Operator
Arrows Indicate Side Motion This Type Lever Arrangement Causes

FOR EVERY TYPE OF FURNACE

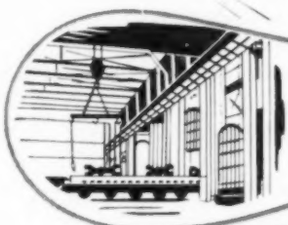




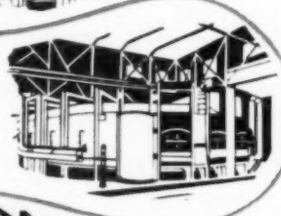
SLAB, BLOOM, BILLET, BAR HEATING FURNACES



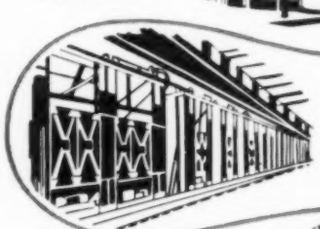
CONTINUOUS PIPE ANNEALING FURNACES



CAR BOTTOM TYPE HEAT TREATING FURNACES



ROTARY HEARTH, BLOOM AND BILLET HEATING FURNACES



BOX ANNEALING FURNACES

STRESS RELIEVING FURNACES

ALSO ROLLER HEARTH AND OPEN HEARTH FURNACES

..rely on RUST from start to finish*

There's a type of Rust Furnace for every metallurgical heating need, designed for any fuel. No matter what type of furnace you need, Rust (pioneers in furnace design) can do the complete job with ONE responsibility from start to finish. Rust patented zone-fired furnaces account for more than one-third of the heating capacity (excluding soaking pits) of America's iron and steel industry . . . surely a significant record . . . Yes, for heating efficiency, operating economy and dependable service, you can rely on Rust.

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* ONE RUST CONTRACT covers everything . . . from blueprint to test-run. Rust assumes responsibility for design, manufacture and erection of all essential material . . . including excavations, foundations, wiring and piping. Your purchasing and engineering departments are freed of subcontractor headaches when you order from Rust.

F-2

RUST FURNACE CO.

PIONEERS IN FURNACE DESIGN

PITTSBURGH, PENNSYLVANIA

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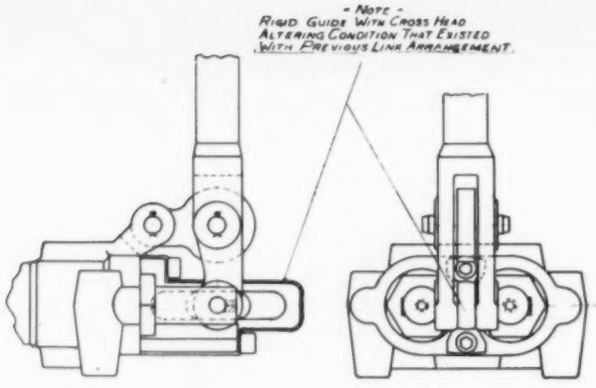


Figure 10 — Alterations were made to this valve which eliminated an unsatisfactory link arrangement.

edge down and cut it off, causing a bad leak between the inlet supply chamber and cylinder passage. This leak would make the valve operate slowly on its return stroke or keep it from operating all together.

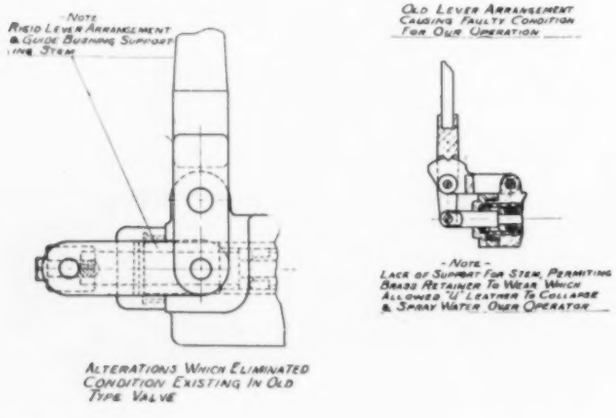
Figure 8 shows another failure we have experienced and eliminated. Through a period of maintaining this valve, it has become necessary to remove it from service, due to the inlet chamber walls cutting out and causing the valve to leak. We have salvaged these units successfully by rebushing the walls of the damaged chambers. This operation has enabled us to lengthen the service record of this unit considerably.

Figure 9, pertains to an experience with one of two apparently suitable ½-in. hydraulic operating valves, used to operate main valves. Both of these valves showed the same type of failure due to the inability of the lever arrangements to lift or pull the stems straight out. These lever arrangements were sufficiently rigid to prevent the stems from being pushed or pulled from one side to the other. This resulted in the top "U" leather collapsing and breaking its proper seal. In Figure 10 it may be seen that this condition was remedied by having the valve manufacturer install a small, rigid guide between the two stems, to act as a cross-head. This did away with the unsatisfactory link arrangement and corrected the fault in the valve for our particular operation. Figure 11 shows the change in design of the lever arrangement and top or bonnet of the second valve. By adding a more rigid lever arrangement and a 1½-in. brass bushing to act as a support and guide, as shown, we were able to correct the condition.

Due to further troubles encountered, it became advisable to change from a hydraulically operated valve to an air-controlled system of our own design. This has been controlling 3-in. and 4-in. operating valves very satisfactorily and has greatly improved working conditions for the operator. After obtaining such satisfactory operation from this particular application, we have ventured further in the field of air-controlled hydraulic operating valves, with encouraging results. The various difficulties discussed in this paper do not only pertain to the particular types of valves mentioned here, but experience leads us to believe that they relate to the majority of hydraulically operated valves in use. It is believed that at one time or another, anyone using hydraulic equipment has had experiences similar to those reviewed.

It has also been found that one of the most important assets in valve maintenance is a reliable, skilled mechanic, one who is capable of understanding the principles of the operation and maintenance of hydraulic operating valves and equipment. This mechanic should be required to make periodic inspection tours of the department, to locate possible trouble, to determine the cause and to make arrangements to remedy wrong conditions as soon as possible. We have found that the successful operation of hydraulic valves depends on a full knowledge of the valve requirements, a sufficient stock of properly made spares, a complete set of tools and jigs, and a well-trained mechanic.

Figure 11 — By adding a guide and a rigid lever arrangement, satisfactory arrangement was obtained from this valve design.



DISCUSSION

PRESENTED BY

WALTER L. DOUGLASS, Lubrication Engineer, Lukens Steel Co., Coatesville, Pa.

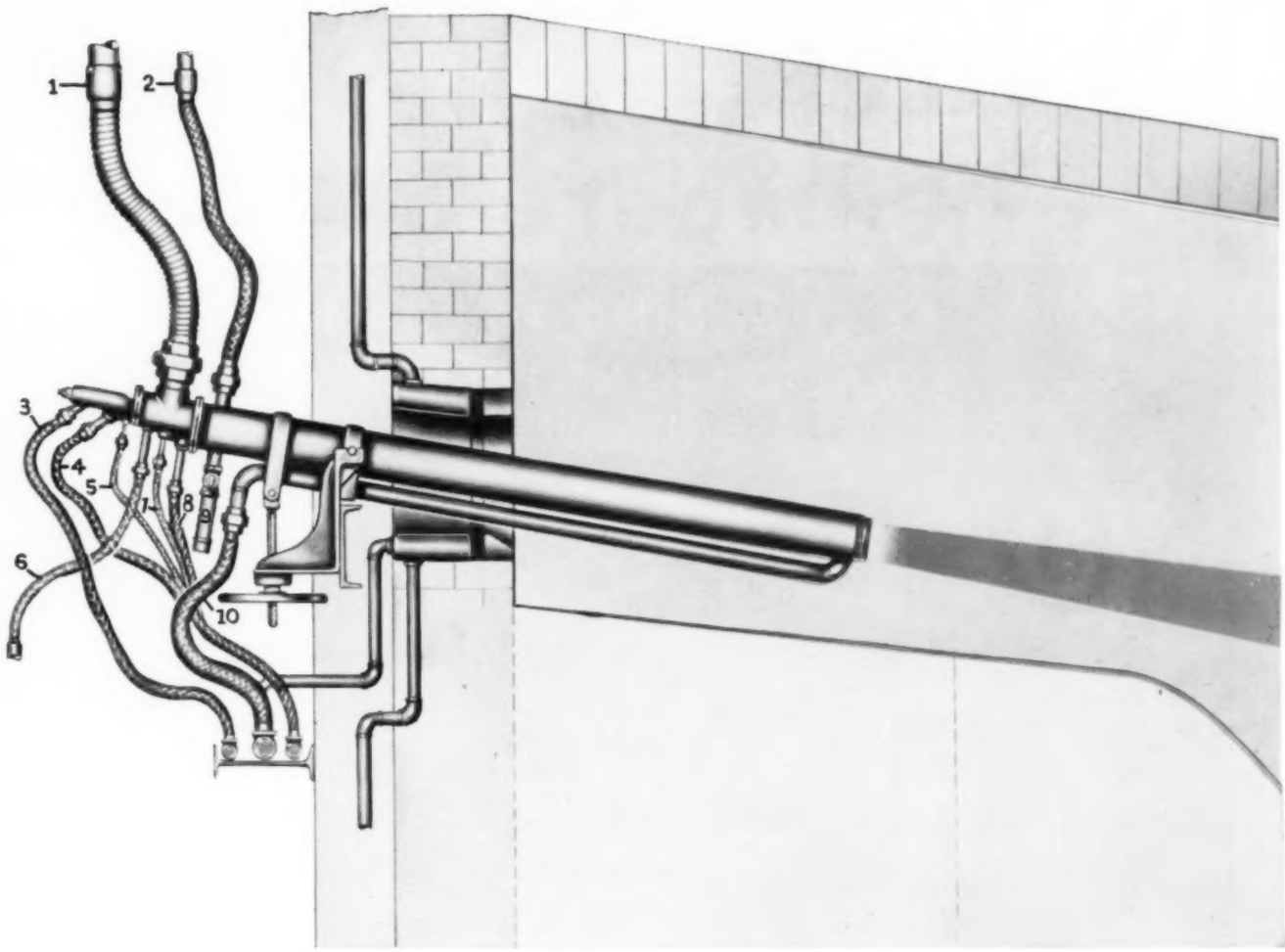
JOHN H. DOTTER, General Millwright Foreman, Plate Mills, Bethlehem Steel Co., Sparrows Point, Md.

W. L. Douglass: We have one problem that has given a mild amount of trouble with the 4-in. three-way valves. We would like to ask if you have had trouble with water by-passing around the bushings, causing a condition which makes it impossible to exhaust from the top of the spindle, thus preventing operation. If you have had such a condition, we would like to know what you have done to eliminate it.

John H. Dotter: Yes, we have had those experiences, but we bored out the valve body and made the face a little larger near the back, where the water would by-pass the upper part of the flange and made a heavier bushing and pressed it in place, thus eliminating that condition.

Incidentally, I wish to state that this paper cast no reflection on any manufacturer of any valve that may be in here — they are merely experiences we have encountered in our operation, and deal primarily on maintenance, not design.

CROWE COMBINATION BURNERS SAVE FUEL



Save time, increase production by eliminating down time for cleaning burners. Crowe Artillery Burners with patented slag deflector built into the burners prevents slag deposits in the burner nose.

Crowe Artillery Burners now in service producing steel averaging 203.4 tons per heat at 22.6 gallons per ton, without cleaning the burners.

Combination Crowe Artillery Burners made to burn gas and oil in combination, oil and oxygen, or straight oil.

All Crowe Artillery Burners made to burn gas in combination with liquid fuels have patented clean out for removing deposits or accumulations in the gas tube.

Produce more steel in less time, increase profits, use Crowe Artillery Burners in your open hearth furnaces.

THE CROWE ENGINEERING CO.
CINCINNATI 14, OHIO

"We Stopped Blows due to excessive Heating in a 600 Ampere Switch...

..BY CHANGING TO FUSETRON DUAL-ELEMENT FUSES"

. . . says W. R. Bishop
Eureka, California

HERE ARE THE FACTS-

"A 600 Ampere 220 volt switch in one of our local schools was causing us a lot of worry. The fuses were running so hot that they were blowing on an average of every 3 or 4 days.

"A salesman told us about the lower resistance of Fusetron dual-element fuses, so we thought we would try them.

"That was more than six weeks ago and not one of the 600 ampere Fusetron fuses has blown. We have checked the switch and find that it is operating at a normal temperature."

W. R. Bishop. Owner
Eureka Wiring Service
Eureka, California

You get 10 Point Protection *by changing to* Fusetron DUAL ELEMENT Fuses

1 * Protect against short-circuits.

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels.

10 Protect coils, transformers and solenoids against burnout.

* Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York City in December 1947.

Here's Why You Get This All-Purpose Protection

The fuse link element opens on short-circuit — the thermal cutout element protects on overloads — the result, a fuse with tremendous time-lag and much less electrical resistance.

They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to the same dimensions as ordinary fuses — fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

There cost is surprisingly low.

(FUSETRON is a trade mark of the Bussmann Mfg. Co., Division of McGraw Electric Co.)

Don't Risk Losses!

One **needless** shutdown . . .
One **lost** motor . . .
One **destroyed** switch or panel
One **burned out** solenoid . . .

May cost you far more than replacing every ordinary fuse with a Fusetron dual-element Fuse.

MAIL THE COUPON NOW

Bussmann Mfg. Co., University at Jefferson
St. Louis 7, Mo. (Division McGraw Electric Co.)
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*Address*_____
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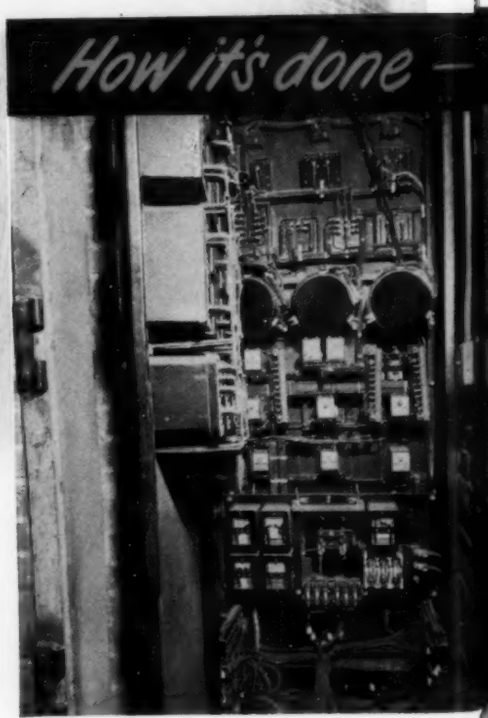
EQUIPMENT FOR THE STEEL INDUSTRY



Furnace Control with Optimelt-Control feature maintains the arc in its most economical phase. No power is wasted; the proper amount is supplied *when* it's needed. Write for IB 31-280 CS-1 and CS-2.

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OUTPUT BOOSTED 5%— AND LESS POWER USED!

Here's news whether or not you're interested in electric furnaces right now. Because the same feel-for-steel engineering that made these remarkable improvements is available to help make your next job better, whatever it is.

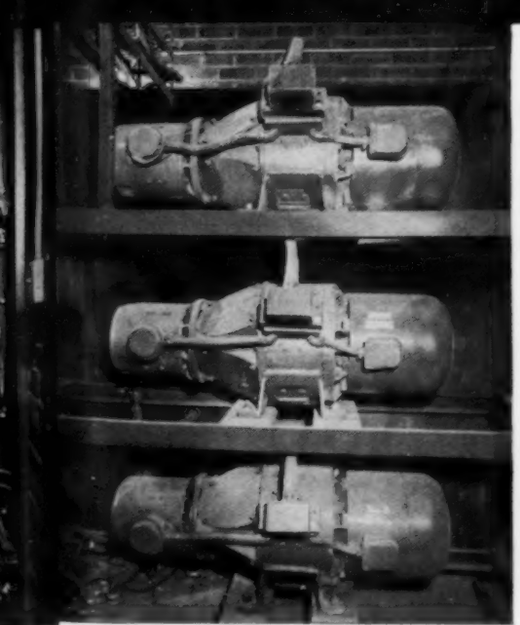
To determine the precise superiority of Westinghouse Optimelt-controlled electric furnaces, one major steel producer pitted them against identical furnaces with manual control. The mill dug up its own proof in a seven-month-long check of actual operations.

Under identical charge conditions, the Westinghouse-controlled furnaces made 5% *more steel per furnace hour.* Yet they actually used 2½% less power per ton of steel poured. And they cut electrode consumption and reduced furnace delays.

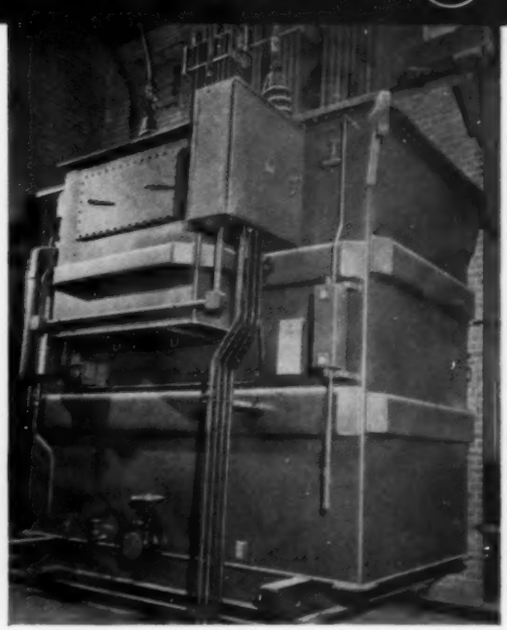
This is the kind of dollar-saving engineering that Westinghouse applies to steel mill electrical equipment. When you're planning your next installation, call in Westinghouse early. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-94846

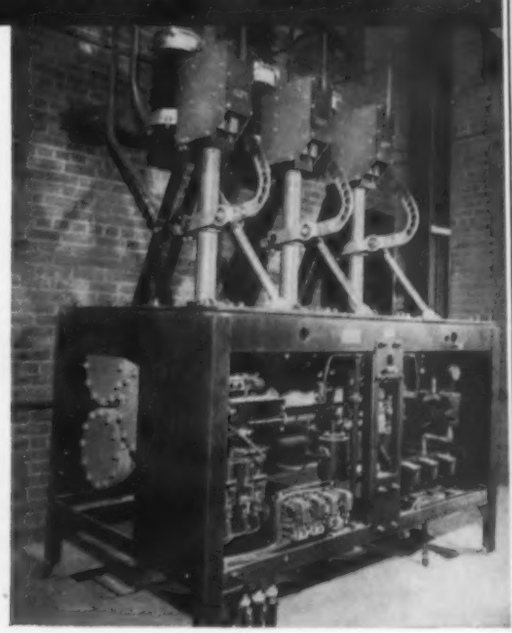
HERE'S THE EQUIPMENT BEHIND THE SUPERIORITY OF Ⓦ-CONTROLLED ELECTRIC FURNACES



Rototrol Regulator positions electrodes quickly, accurately, and *automatically* as furnace conditions change. Shown above: M-G sets for positioning three electrodes with Rototrol unit mounted at left end of each.



Furnace-type Transformer continually transforms main mill power for exacting furnace requirements. Transformer is built in shell construction for maximum bracing strength and optimum cooling conditions.



Compressed Air Circuit Breakers are specially designed for the severe repetitive duty of arc furnace operation. They withstand 15,000 operations between inspections. Surge suppressors reduce overvoltages.

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Date-line Diary...

August 1

▲ Weirton Steel Co. announced that it would comply with the order of the Circuit Court of Appeals and withdraw recognition from the Weirton Independent Union, Inc.

August 2

▲ Irving S. Olds, chairman, United States Steel Corp., announced that it would order construction of four 18,000-ton capacity vessels for hauling of iron ore and limestone.

▲ It was announced that Bethlehem Steel Co.'s construction program at Sparrows Point is now about 25 per cent completed.

August 3

▲ Engineering construction projects started in July were estimated at $1,175,000,000 for a new high according to Engineering News Record.

▲ Stewarts & Lloyds, Ltd., British iron and steel tube manufacturers, negotiated contracts with American firms for production of steel pipe lines for shipment to the United States at an estimated cost of $5,600,000.

▲ The Jessop Steel Co. is putting into effect immediately a reorganization plan which clears the way for them to obtain a $1,000,000 RFC loan.

August 4

▲ The American Railway Car Institute announced that domestic freight car orders during July totaled 30,065 for the largest monthly figure since 1924. Deliveries during July totaled 3,464 leaving a backlog on August 1st of 67,084 compared with 40,585 on July 1st.

▲ Executives of a number of steel companies told the Department of Commerce that they would cooperate in tightening steel export controls.

August 5

▲ Armco Steel Corp. has announced that it will spend about $1,500,000 to modernize and expand its Zanesville, Ohio plant.

August 6

▲ Carnegie-Illinois Steel Corp. is increasing open hearth capacity at Youngstown, and has announced that it will install two new turboblowers for the six blast furnaces which will increase iron output by 800 tons daily.

▲ The Republic Steel Corp. is planning to enlarge a 100-ton furnace to a 200-ton unit at Buffalo. It will also install a 125,000 cfm turboblower at the Cleveland No. 5 blast furnace.

August 7

▲ B. C. Colcord, President, Woodward Iron Co., announced that it is constructing a $4,500,000 blast furnace adjacent to its present No. 2 furnace at Woodward, Ala.

▲ Based on reports from companies having 94 per cent of the steel capacity of the industry, the operating rate for the week beginning August 7, 1950 is scheduled at 99.9 per cent capacity. This is equivalent to 1,926,800 tons compared with 1,919,600 tons one week ago. This percentage figure is based on the new higher rated industry capacity of 100,563,500 tons which took effect July 1, 1950.

▲ A new independent union was organized at Weirton Steel Co. called the Independent Steel Workers Union. William Huff is the temporary president.

August 8

▲ Charles E. Wilson, president, General Electric Co., announced that the General Electric Co. could double its World War II output rate.

▲ Pittsburgh Steel Co. has purchased a high lift blooming and slabbing mill from United Engineering and Foundry Co.

August 9

▲ AISI announced that employment in the iron and steel industry in June totaled 635,900. Total payroll was $195,332,000 with an average rate of $1.714 for an average work week of 39.3 hrs.

▲ The American Petroleum Institute revealed that domestic crude oil production last week was 5,640,350 bbl daily or the highest this year.

August 10

▲ The Aluminum Association reports that the aluminum industry produced 360,707,827 lb of primary aluminum during the second quarter of 1950, or 12 per cent above the first quarter.

▲ Central Iron and Steel Co. has completed arrangements for the purchase of the blast furnace at Chester, Pa. and will put it in operation as soon as possible.

▲ According to Department of Commerce, business inventories in June increased $200,000,000 to $55,300,000,000.

August 11

▲ Spot tin price in New York went up to $1.05 a lb.

August 12

▲ The Alpine-Montan Gesellshaft will build a rail and structural mill with a capacity of 165,000 tons per year at an estimated cost of $6,100,000 of which ECA will contribute $2,000,000.

August 13

▲ Corporacion Venezolana de Fomento of Caracas, Venezuela signed a contract with the Salem Engineering Co., Toronto, Ontario, to make a survey for a steel plant.

August 14

▲ Based on reports of companies having 94 per cent of the capacity of the industry, the operating rate is scheduled at 100.1 per cent for the week beginning August 14th. This is equivalent to 1,930,600 tons compared with 1,926,800 tons one week ago.

▲ The Lukens Steel Co. announced increases in base price of carbon and low alloy steel plates of 30¢ a 100 lb giving a new price of $3.90 and $4.80.

▲ Commerce Department reported that the gross national production for the second quarter in 1950 reached a new high with an annual rate of $270,000,000,000.

August 15

▲ United Engineering and Foundry Co. reported that in the first six months of 1950 net income was $3,422,625 or $4.14 a share compared with $3.09 a share for the same period in 1949. Completed orders for the first half totaled $36,489,448.

▲ Price of lead advanced 1¢ to 13¢ a lb in New York.

August 16

▲ American Iron and Steel Institute reported that the United States made 47,106,000 tons of steel in the first half of 1950 for a new high for a six month period.

▲ Copperweld Steel Co. bought all the facilities built by the RFC during World War II at its Warren, Ohio plant for $2,000,000. Included are three electric furnaces already under lease to the company.

August 17

▲ Republic Steel Corp. has reopened the No. 3 melt shop in Canton, Ohio. This is government owned and Republic is now operating two of the five 70-ton electric furnaces.

▲ Bethlehem Steel Corp. and a Brazilian Co., Industria e Comercio de Minerios (Icomi), have set up plans for the development of manganese deposits in the lower Amazon Valley. It is estimated that there are from 10,000,000 to 20,000,000 tons of ore reserves assaying 44 per cent manganese or better.

▲ The Pennsylvania State Employment Service estimated that Pittsburgh area plants may have to go out of the district to obtain certain types of skilled workers.

▲ Tennessee Coal, Iron and Railroad Co. was closed down by a strike caused by an argument over a job classification.

▲ The Brotherhood of Railroad Trainmen and the Order of Railway Conductors ordered a five day strike to start Tuesday, August 22nd on the Elgin, Joliet & Eastern Railroad, and the Pittsburgh & Lake Erie Railroad.

August 18

▲ The AISI reported that accidents in 1949 set a new low in the steel industry, which was the fourth safest of 40 major industries. There were 4.96 accidents per 1,000,000 man hours worked compared with 10.14 for all industries. Accident severity was also lowest on record.

August 19

▲ The Loftus Engineering Co. received a $500,000 contract for the engineering on five open hearth furnaces for the Finsider Co. in Italy. Furnaces are to be located at the Cornigliano Works which is near Genoa.

August 21

▲ Based on reports of companies having 94 per cent of the capacity of the industry, the operating rate is scheduled at 90.6 per cent of capacity for the week beginning August 21st. This is equivalent to 1,747,400 tons compared with 1,930,600 tons one week ago. Reduction from the previous week is caused by railroad strikes.

▲ Robert W. Wolcott announced that foreign countries will furnish from 400,000 to 500,000 tons of steel scrap by the end of this year.

August 22

▲ The Whitney-Apollo Corp. announced that its new sheet steel division at Portsmouth, Ohio will go into operation around September 11th.

▲ Lukens Steel Co. sold its financial holdings in its E & G Brooke Iron Co., Birdsboro, Pa. to Bayou Interests, Inc. of N. Y.

▲ The General Motors Co. is raising wages of workers 5¢ an hour in accordance with the cost of living formula.

▲ The Bureau of Internal Revenue announced that federal tax collections during the fiscal year ending June 30th totaled $38,957,000,000 or $1,500,000,000 less than the previous year.

▲ In testimony before the House of Appropriations sub-committee, it was estimated military expansion will use about 4,000,000 tons of steel during the fiscal year ending June 30, 1951.

▲ National Machine Tool Builders Association reported that machine tool orders in July reached an index of 253.3 for the highest since May, 1943.

August 23

▲ The AISI reported that the United States exported 4,682,110 tons of steel in 1949 for a slight increase over the previous year. The five leading importers were Canada, Venezuela, United Kingdom, Mexico and Union of South Africa in that order.

▲ A new battery of 61 coke ovens with an annual capacity of 300,000 tons is now in production at the Clairton Works of the Carnegie-Illinois Steel Corp.

▲ Sharon Steel Corp. announced that it will close down one of its three blast furnaces for about sixty days starting September 3rd for relining. As a result of the shutdown some open hearth capacity will be closed.

▲ The Defense Production Bill now going through Congress contains powers which will enable the government to direct the growth of industry. Included in the plan are such items as production goals, guaranteed markets, loans, subsidies, privileged allocations, research aid and tax benefits.

▲ Lewis Foundry & Machine Co. received an order from the Alpine Montan which covers the purchase of three rolling mills and auxiliary equipment for processing cold rolled steel strip up to 18 in. wide.

August 25

▲ The Chrysler Corp. announced that it had agreed to increase wages 10¢ an hr for the hourly rated workers with some getting 15¢. This increase was over and above contract recently concluded.

▲ The Allegheny Ludlum plant at Dunkirk was shut down by a strike for the second time in two weeks.

▲ Phillip Murray personally appeared in Weirton for the opening of the CIO drive to organize the workers of the Weirton Steel Co.

August 28

▲ The Army took over the United States railroads thus averting a nationwide railroad strike. The two railroads already out on strike, the P & L E Railroad and the Elgin, Joliet and Eastern Railroad also went back to work.

▲ Based on reports from companies having 94 per cent of capacity of the industry, the operating rate is scheduled at 97.1 per cent for the week beginning August 28, 1950. This is equivalent to 1,872,800 tons compared with 1,747,400 tons one week ago.

▲ The AISI reported that consumption of natural gas by the steel industry set a new figure of 399,000,000,000 cu ft in 1949 for an increase of 45 per cent over 1948. Fuel oil used totaled 1,800,000,000 gal or 16 per cent under 1948, electricity totaled 19,700,000,000 kwhr 15 per cent under 1948 and coal totaled 82,870,000 tons, down 15 per cent from 1948, and scrap was over 41,000,000 tons, 12 per cent under 1948.

▲ President Truman signed the bill which brings 10,000,000 additional persons under the Social Security plan.

▲ The Committee for Economic Development estimates that military spending will rise from the present annual rate of $15,000,000,000 to about $35,000,000,000 a year from now.

August 29

▲ The American Institute of Steel Construction reported the July bookings of fabricated structural steel totaled 265,771 tons compared with 126,255 tons one year ago. Shipments in July totaled 132,367 tons compared with 147,960 tons one year ago, leaving a backlog available for fabrication in the next four months of 684,538 tons.

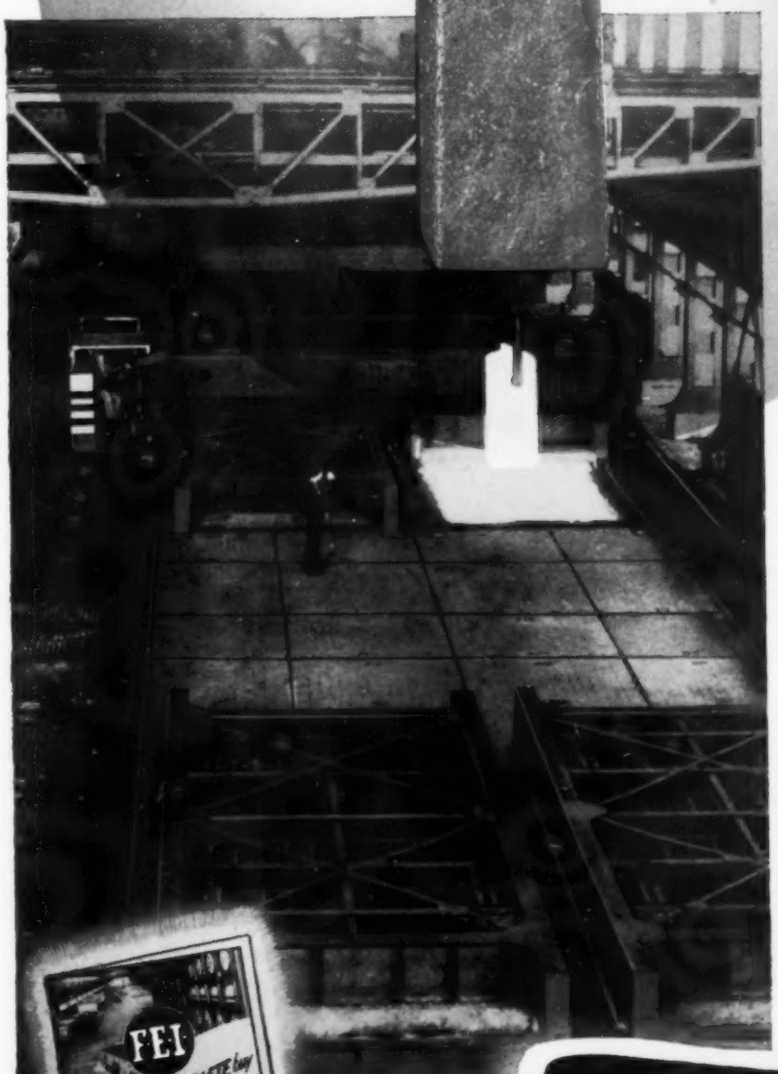
August 30

▲ H. C. Frick Coke Co. announced that a new 4000-ton a day coal mine will be opened in Washington County, Pa. and another mine about the same size which has been closed since 1928 will be reopened in Fayette County.

The Complete Buy **F·E·I** *for Greatly Improved*

INGOT HEATING

new regenerative soaking pits



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MODERN TO THE Nth DEGREE . . . Latest records show greatly increased output of ingots with minimum fuel consumption.

FIRED BY COLD BLAST FURNACE GAS or any other fuel. F.E.I. Soaking Pits provide extremely high preheated air temperatures.

UNIFORM HEATING, controlled automatically. No impingement. No overscaling. No washing. Minimum maintenance... Bottom making practically eliminated. This is due to extremely accurate control of temperature and atmosphere.

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F-4

Write for This Bulletin covering all types of F.E.I. Heat Treating Furnaces.

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Industry News...

WEIRTON STEEL TO CONSTRUCT COAL STORAGE AND RECLAIMING SYSTEM

▲ Weirton Steel Co. has awarded Koppers Co., Inc., a contract for the construction of a coal storage and reclaiming system at its Weirton, W. Va., coke plant.

This coal storage system will consist of additional equipment and alterations to existing equipment, which will enable Weirton to handle 500 tons of coal per hour into the coal storage area, with a similar capacity when reclaiming coal for use in the coke ovens. The system will allow about 250,000 tons of coal to be stored on the site, and is scheduled for completion before May 1, 1951.

Included in the contract will be a new 600-ton capacity balance bin for receiving coal from the barge unloader on the Ohio River, a 60-ton capacity diesel-electric transfer car to deliver coal from balance bin to storage area, and an electrically operated traveling tower with grab bucket which will be used with bulldozers to store and reclaim coal. The runway for the traveling tower will be about 565 ft long.

A reclaiming hopper will be built into this traveling tower to load the transfer car which will return the storage coal to a new track hopper, from which it will be fed into the existing coal handling system at the ovens. The new system also will be arranged to permit coal to be dumped directly from railroad cars into the storage area.

CRUCIBLE AND REMINGTON JOIN TO MAKE TITANIUM

▲ Officials of the Remington Arms Co., Inc., Bridgeport, Conn., and Crucible Steel Co. of America, New York, N. Y., announced plans for the formation of a new and jointly-owned company. In this new company will be pooled knowledge, patents and manufacturing techniques developed by Remington and Crucible for the production of titanium metal and titanium metal alloy products. These products include sheets, rods, tubes, wire, forgings, castings and other fabricated forms for widespread industrial uses. It is contemplated that all operations will be moved to Pittsburgh, Pa., at a later date.

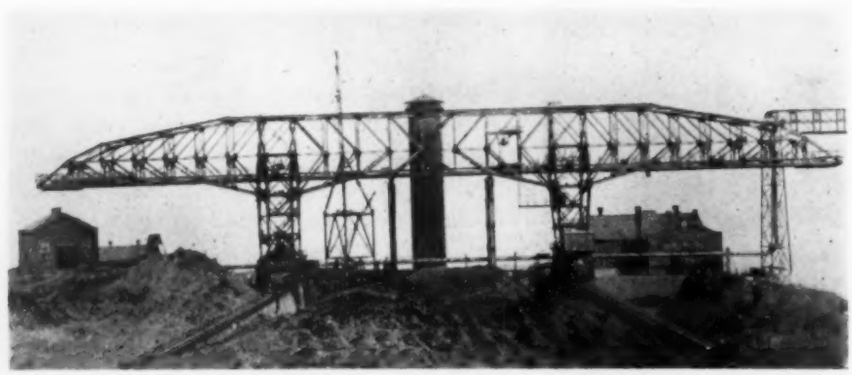
Titanium, a light, strong metal of great promise, has been the subject of much industrial interest in recent years. While building its organization and new facilities, the new company will continue a full-scale research, development and manufacturing program. It will also continue to supply quantities of titanium materials for industrial application studies, now in progress, principally in the aircraft industry.

Because titanium combines lightness (about half as heavy as steel) and strength (stronger than aluminum and comparable with certain grades of steel), its application as an aircraft structural material is of particular interest. The metal also possesses remarkable qualities of resistance to corrosion, and its many possible alloy combinations give promise of numerous special applications. These combined qualities make titanium of high interest to a number of industries, including the transportation, chemical, food, marine, machinery and metal-working fields.

Titanium ore, of which there appears to be an abundant supply in the United States and elsewhere in the world, is usually found with other elements and compounds, from which it must be separated. At the present time, titanium metal in the form of sponge is made from this ore. Under present plans, the new company formed by Remington and Crucible will depend upon sources now available for its supply of titanium sponge.

While some of Crucible's facilities will be used in the processing of the titanium products, there will be no change in the normal steel operations in the Crucible plants.

NEW ORE BRIDGE BEGINS OPERATION AT GARY



The second of a pair of new ore bridges recently went into service at Gary, Ind., steel works of the Carnegie-Illinois Steel Corp., incorporating all developments learned in a year of operation of the first bridge. The 25-ton bucket is operated through two 5 ft 1⅝ in. pitch diameter cable drums. Each drum is driven by a 325 hp motor and a 24 in. center distance Cone-Drive speed reducer with double-enveloping gearing. Handling 22½ tons of ore per load, the bridge can transfer 24,000 tons of ore per day.

NEW TEXAS PIPE PLANT BEGINS PRODUCTION

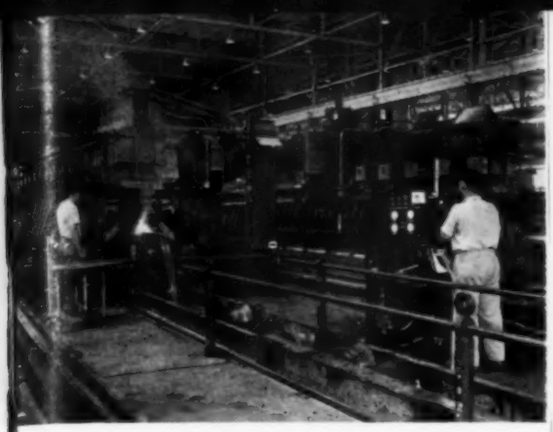
▲ Production of large diameter welded steel pipe for the nation's oil and gas industries has begun at the $85,000,000 plant of the A. O. Smith Corp., Houston, Tex.

Completed on schedule on August 1, the plant, after a few days of shakedown operation, is now turning out "big inch" pipe in increasing volume.

A. O. Smith Corp. of Milwaukee, Wis., and Sheffield Steel Corp., a subsidiary of Armco Steel Corp., are joint owners of the pipe mill.

The pipe plant, second largest of its kind in the world, employs more than 400 persons and is scheduled to reach production of approximately 40,000 tons of pipe per month in October.

A new plate mill installed by Sheffield at its nearby plant to produce skelp for the pipe mill and to increase



The new plant is equipped to make pipe in sizes from 16 to 36 in.

the supply of plate available for other purposes, is now partially in production.

In order to meet an urgent need for large line pipe, the plant was rushed to completion by Austin Co., engineers and builders.

Ground was broken in October, 1949, 15 days after Austin received the contract to design the building and to construct it and install its machinery.

The plant will be operated on a three-shift basis, with 25 production days per month. It is equipped at present to make pipe in sizes from 16 to 36 in. Additional facilities to be added later will broaden its size range from eight and five-eighths inches to 36 in.

Scheduled for future construction are casing facilities which will be operated in conjunction with the pipe mill. The plant is tooled up at present to produce 1000 miles of 30-in. pipe for the Texas-Illinois Pipe Line Co. which will supply natural gas from southeast Texas to the People's Gas Light and Coke Co. of Chicago, Ill.

Sheffield's new plate mill contains 200,000 sq ft of floor space or nearly five acres. It houses a new and completely modern plate mill which can produce plates up to 115 in. wide and 40 ft long, for pipe up to 36 in. in diameter, in addition to supplying additional plate for other purposes in quality and sizes not previously available at the Houston plant.

Fabrication of the pipe is a three step process, beginning after the raw skelp has been chemically cleaned in the pickling building. A large hydraulic press makes the plate U-shaped. A second press partially closes the open ends to make it oval or egg-shaped and a third makes it cylindrical.

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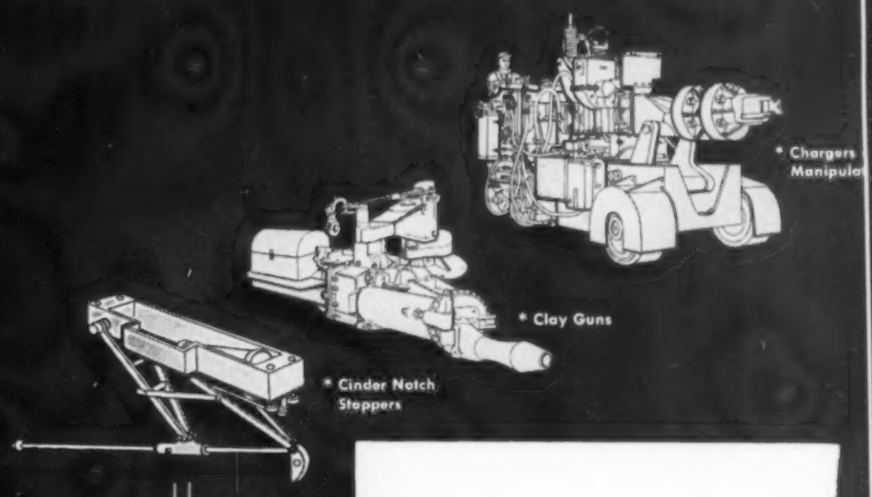

*

When you buy any of the products shown on this page for furnace or mill or forging floor, it will pay you to specify BROSIUS. Wherever you see the well-known mark of BROSIUS, you'll find equipment keenly and specifically designed to do the best job according to the needs of the plant for which it was intended . . . you'll find ruggedly-built and sensibly-engineered machinery easy to operate and maintain. Write without obligation for detailed information on any BROSIUS product. Call on us today.

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What should you expect of Conveying Equipment?

● Conveyers and conveyer systems should be designed to meet specific problems. A purchaser has every right to expect that the conveying equipment he buys is the type that will best meet his requirements. He just can't afford trial and error methods. That's why more and more people are giving their conveying problems to Mathews Engineers, and are getting just what they should expect—a system of quality equipment, engineered to meet their specific requirements.

Whether the loads are heavy or light—whether you need two sections or a complete system of equipment—your Mathews Engineer is eager to help you to get just what you need and to give you the service you should expect.

Field Engineers or Sales Agencies are located in principal American and Canadian cities.

MATHEWS CONVEYERS

GENERAL OFFICES . . . . . *Mathews Conveyer Company*
ELLWOOD CITY, PENNSYLVANIA

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CANADIAN DIVISION . . . . . *Mathews Conveyer Company, Ltd.*
PORT HOPE, ONTARIO

MICA PLANT NEARS PEAK PRODUCTION

▲ Westinghouse Electric Corp. is nearing peak production at its new plant near Irwin, Pa. With a goal of 300 employes now in sight — 220 already are on the rolls — the new plant soon will reach full-scale operation in the processing of mica insulation for electrical equipment and in the manufacture of an entirely new insulating material.

The 20-acre site, comprising four three-story buildings with 125,000 ft of working space, is devoted to the processing of mica flakes into tape, fabricated parts and sheets, all of which are used for insulation of motors, generators, and a wide variety of other electrical apparatus.

A revolutionary new type of insulation that "bounces back" after extremes of temperature now is being produced at the plant. Called "Thermalastic," the new material answers a long-felt need for an insulating material in large steam-driven generators, in which it is expected to provide a 10-times increase in life expectancy over previous materials. A substantial stockpile of mica has been accumulated at the new plant.

Some mica insulation for electrical equipment is built up layer by layer by hand. Here, employees of the Westinghouse mica plant deftly lay mica flakes in carefully overlapped rows on a slowly moving resin-impregnated paper sheet. The four cylinders that span the work table are filled with the bonding resin which drips evenly over the entire width of the sheet.

Hand building of mica insulation for electrical equipment is a slow and tedious process. Here at the Westinghouse mica plant, deft hands produce mica insulation for electrical apparatus.

In charge of the new plant is C. M. Clark, manager of manufacturing for the Westinghouse Transportation and Generator Division which uses some 80 per cent of the mica materials produced here. John S. Askey is superintendent of manufacturing operations at the plant.

New automatic machinery features the plant's production facilities. One machine — 150 ft long — takes in mica flakes at one end, tumbles them into a finely divided "snowfall," and drops them in smooth layers on a constantly moving sheet covered with resin. At the other end, the sheets — called mica plates — are cut and stamped to size, depending on the application. Another machine tests the mica sheets for their electrical properties, and automatically comes to halt if defects are located.

For custom-built insulation, involving electrical equipment with extremely high voltages, the mica is hand-laid by deft-fingered girls who build up consecutive layers of mica in canasta-fashion.

DEEP WELL CASING MADE BY NATIONAL TUBE

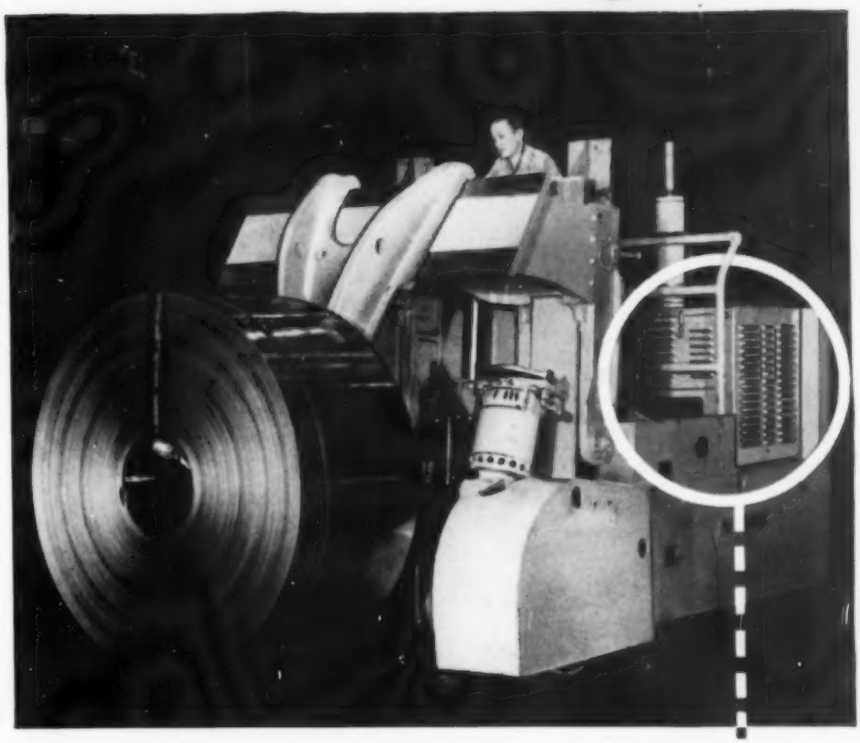
▲ National Tube Co., Pittsburgh, Pa. announces the development of a new product to meet the oil industry's modern trend toward producing deep wells, to be named "National Deep Well Casing."

This new product is the result of an extensive program of research and experiment instituted by National Tube for the development of a tougher, stronger, higher yield casing. It is made from quenched and drawn steel having a far higher minimum yield

constant power

FOR THE WORLD'S FASTEST STRIP MILL

Weirton Steel Works, Weirton, W. Va.

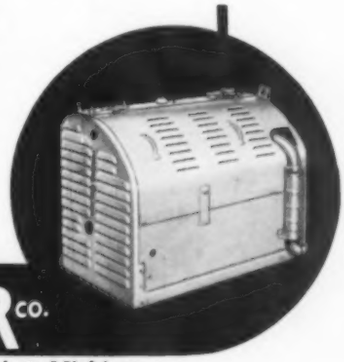


constant power

WITH READY-POWER-EQUIPPED ELECTRIC TRUCKS

Illustrated at top is one of two 2250 HP Motors at the Weirton Steel Works, Weirton, W.Va. furnishing *constant power* to drive the finishing rolls of the world's fastest cold-reduction strip mill capable of mile-a-minute production.

Equally constant and dependable is the power provided by the Ready-Power gas-electric unit on the "Automatic Skylift Giant" electric truck shown carrying one of the mill's 30,000 lb. rolls of finished strip. For electric trucks of any make or type, new or old, where constant power for hour-after-hour operation is needed—specify Ready-Power.



THE READY-POWER CO.

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"MULTICUT" "TUFCUT" "HOT WORK"

Wapakoneta
SHEAR BLADES
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Any type or size blade of proper Alloy with correct hardness and temper for every type shearing machine and every kind of job.

Rx ENGINEERED TO THE JOB

Every Wapakoneta blade is made to exact specifications, designed for the particular job. Complete records with order number of each blade makes possible duplication of exact size and temper at any time.

The WAPAKONETA MACHINE CO.
Shear Blade Specialists Since 1891
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strength than the present top standard grade of casing, and special facilities for its production have been installed, comprising the most modern heating and quenching equipment available.

The new deep well casing will permit greater safety and efficiency in the difficult and often hazardous task of deep well drilling. Depending upon the specific size of the casing involved, the price of the new product ranges from $186 to $198 per ton.

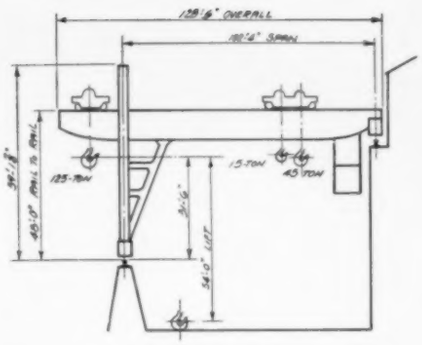
GANTRY CRANE AT LORAIN IS UNUSUAL

▲ The 125 ton single-leg gantry crane installed at the National Tube Co., Lorain, Ohio, serving the bessemer converters, is unusual, not only because it is the biggest of its type ever built, but also because of its shaftless bridge drive. The crane was built by Cleveland Crane & Engineering Co. Heretofore, bridge drives for all long span semi-gantries have employed motors, mounted on the bridge girders, arranged to drive the track wheels through line shafting, flexible couplings, bevel gears and universal joints. Most of these have been a source of maintenance difficulties to users.

The all-welded design of this crane, incorporating a welded box-section portal-type leg, provides maximum torsional rigidity to assure proper alignment of all parts and successful operation of the individual motor bridge drives. The hermetically sealed welded box sections used for both girders and leg, provide maximum resistance to corrosion, always a problem in the bessemer area.

The bridge of the crane rides on eight equalizing-type two-wheel trucks, four of which are located at the gantry leg and four at the wall end of the crane girders. For each pair of

This single-leg gantry crane has a shaftless bridge drive.



All-welded design of this crane provides maximum torsional rigidity.

trucks there is a direct connected individual motor drive, making four bridge drive motors in all. No provision is made to electrically synchronize the motors.

ELECTRO METALLURGICAL BUILDS MICHIGAN PLANT

▲ A new plant for the production of electrolytic chromium will be constructed at Sault Ste. Marie, Mich., by the Electro Metallurgical division, Union Carbide and Carbon Corp., New York, N. Y. It is expected to be in operation in the spring of 1951, and will adjoin Union Carbide's extensive facilities there for the production of calcium carbide.

The electrolytic chromium operation will be based on an entirely new process, many important steps of which were developed by the Bureau of Mines, U. S. Department of the Interior. Other steps developed by the Corporation's laboratories have been integrated with these to make large-scale operation economical. The metal produced by the process is said to be of a higher degree of purity than any commercially produced chromium metal now available.

Principal use for electrolytic chromium is in the special non-ferrous chromium alloys used for metal-cutting tools; heating elements for many electrical appliances, such as toasters and irons; and various parts operating at high temperatures in jet engines and rockets.

PROTECTIVE COATING FIRM PURCHASES PLANT

▲ Houghton Laboratories, Inc., manufacturer of protective coatings for the chemical, petroleum, plating and general industrial fields, has purchased a new plant at Smethport, Pa. Formerly the property of Susquehan-

When Choosing Clutches and Brakes for Your Equipment, Look Over These

CHECK POINTS OF FAWICK SUPERIORITY

In selecting clutches and brakes for your machinery, Fawick is your logical choice. Check these six points of Fawick superiority.

1 DRUM-TYPE AIR OPERATION
Fawick clutch and brake units provide a 360° friction surface and uniform-pressure, constant-velocity contact between the full width of the friction shoes and the drum. Greatest operating torque results from the application of operating pressure at the maximum diameter.

2 OPTIONAL CONTROL
Local or remote finger-tip control of instantaneous and smooth starting and stopping increases operating efficiency. Clutch or brake action can be sensitively regulated while units are in operation.

3 SELF-ADJUSTING
The rugged Fawick actuating element automatically compensates for wear of friction shoes. This insures complete engagement and dependable service from Fawick clutches and brakes.

4 LOW MAINTENANCE
Even friction-shoe wear reduces lost production time for clutch or brake maintenance. After long periods of satisfactory service, only the friction shoes need be replaced.

5 NO LUBRICATION
Fawick design and construction eliminate the problem of clutch or brake lubrication.

6 SPACE-SAVING
Space requirements for Fawick installations are minimized due to the small number of moving parts and elimination of mechanical linkages. All conventional mounting arrangements are made with a substantial saving of vital axial space.

A Fawick clutch or brake of the correct type and size to meet your machine design and operating requirements is the best solution to your application problem. Check with Fawick before you buy.

All desirable clutch characteristics are built into Fawick Airflex units

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FAWICK CLUTCHES = + + + = PEAK EFFICIENCY
AXIAL CONTACT · 360° RADIAL CONTACT · SHOCK ABSORPTION · CONTROLLED TORQUE

LUBRICATION DAN SEZ:

EDISON GAVE US LIGHT IN 1879

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PUT NEW LIGHT ON LUBRICATION

CHECK THESE 9 IMPORTANT FACTS:

1. EXTREME PRESSURE pH-film STRENGTH of 50,000 lbs. per square inch minimum by "Timken" testing machine.
2. ADHESIVENESS in which affinity for steel and other metals develops maximum adhesion and prevents drippage or creeping. Retains a flexible coating in nature.
3. WATER REPELLENCE which retards washing off, creates a lubricating pH-film under moisture or water conditions.
4. CORROSION PREVENTION is an excellent protective coating in that it will not etch or corrode metals. Is never acidic.
5. COMPOUNDED STABILITY—Will not bleed or change physical condition within range of higher than usual temperatures for this type of lubricant.
6. LOW TEMPERATURE FACTORS—While having a solidifying action by decreased temperature as low as —40 F., it does not harden, crack or decrease in adhesion. The flexible coating withstands distortion of the application.
7. ABRASIVE RESISTANCE—Extremely high for a lubricant. Does not wipe off nor will be removed in handling by workmen's hands or gloves. Is extremely repellent to adhesion of scale, metallics and other forms of dusts or contamination.
8. Klingfast has remarkable corrosive resistance to salt or sea water, acidic vapors and solutions.
9. Klingfast can be removed by ordinary solvents such as kerosene, gasoline, naphtha, carbon-tetrachloride and similar substances but is highly impervious to lubricating oils and greases.

NOW it can be told! An important manufacturer of ferrous material—one of the most critical buyers in the industry—test and set up their own lubrication specifications—*and it has to be a top quality lubricant to meet them.* KLINGFAST met all these rigid tests with "flying honors" and notification has been sent to all of their plants to use KLINGFAST on *open gears* and many other tough jobs. Proof again that Brooks Products, in the face of strict competition, rigid specifications, and the toughest job applications, are superior.

Talk over your "tough" assignment with the Brooks engineer when he visits your plant—or write today for outstanding case histories of Brooks Lubricants—*on the job.*

The Brooks Oil Co.

Since 1876

Pittsburgh 12, Pennsylvania
Cleveland, Ohio
Hamilton, Ontario

Warehouses: In Principal Industrial Cities

na Chemical Co., this new plant will be used for the production of the Hysol series of protective coatings. With three main buildings on a 17 acre tract, this plant has 20,000 sq ft of floor space and a 350,000 gal liquid storage capacity.

WESTINGHOUSE SHIPS ELECTRIC FURNACE ABROAD

▲ A large high-temperature electric furnace has just been shipped to the Lysaghts New Castle works, New South Wales, Australia by the industrial heating section of the Westinghouse Electric Corp. at Meadville, Pa. It will be used to anneal high-silicon-content steel, which is essential in the production of power transformers.

The rectangular bell-type furnace is capable of heating 50,000 lb of steel to a temperature of 2000 F in only 70 hr. The 102,000-lb furnace and its related equipment was shipped on two railroad flat-cars, with the furnace completely bricked and piped, and the heating elements installed.

ATLANTIC STEEL STUDIES PRODUCT DIVERSIFICATION

▲ In response to the marked growth of metal-working industries throughout the South, and to increased demand for diversification of its own products, the Atlantic Steel Co., Atlanta, Ga., announced formation of a product engineering department.

R. S. Lynch, president, stated that the new department had begun operations effective August 1, 1950. He defined the objectives of the unit as including: (1) Arousing of consumer interest and stimulation of sales so as to hold or increase the company's share of existing markets. (2) Utilization of idle production and sales facilities through opening of new markets. (3) Diversification of product lines so as to reduce seasonal and long-term fluctuations in production and sales. (4) Direct services to Atlantic customers as well as to other metal consumers and fabricators in the form of free consulting-type assistance in such areas as product design, plant lay-out, fabrication problems, metallurgical problems, market surveys and analysis and other similar manufacturing and marketing problems.

In commenting on the long-range program of product development which his company is planning, Mr. Lynch stated: "Atlantic Steel Co. is widely recognized as one of the two or three most diversified steel mills in the United States. Not only does industry in the southeastern region afford us at this stage of its development a great opportunity for keeping our own products adapted to its needs; but it is also our decided obligation to Southern industry and agriculture to create research and development services which are predicated on broadening the productive capacity of industry in the region, to help them to improve their application of steel in the processing of their products, and to offer other direct aids which will result in improved quality and design of finished steel products made by Southern manufacturers."

BRAZILIAN FIRM BUYS ELECTRICAL EQUIPMENT

▲ Installation of Westinghouse electrical equipment is now being made in a new reversing hot-strip steel mill of Companhia Siderurgica Belgo-Mineira at Monlevade, Brazil.

The Westinghouse apparatus includes a 2000-hp main drive motor, a

EF Special Atmosphere Roller Hearth Furnace Continuously Bright Normalizing Two Strands of 27" Strip — Capacity 7200 Lbs. Per Hour.

ANNEALING STRIP STEEL *Continuously* **IMPROVES THE DRAWING QUALITIES**

● EF continuous annealing and normalizing furnaces subject the entire length, and width of the strip to *exactly the same* time and temperature treatment, resulting in extreme uniformity of grain size, yield point, and completeness of recrystallization; — all definite advantages for deep drawing. They tie-up a minimum amount of material in process; — usually *cost less* than batch equipment of equivalent capacity; prevent scaling; eliminate pickling; avoid the need of "rider strips," and danger of scratching.

Capacity to 28,000 lbs. or more, per hour — single or multiple strands up to 54", or wider. Send today for completely descriptive literature and treated samples.

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THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

Salem - Ohio

1750-kw motor-generator set, various "Rototrol" rotating regulator control units, and auxiliary motors ranging up to 250 hp.

The main mill motor and the motor-generator set will be ventilated by air passing through Westinghouse "Precipitron" electronic air cleaner units which remove airborne particles by electrostatic attraction.

Located in Minas Gerais province near the country's richest source of iron ore, Belgo-Mineira is the oldest and largest private steel producer in Brazil. Its output includes sheet steel, rod and wire products, and railway rails.

NATIONAL CARBON CONSIDERS EXPANSION

▲ Pending formal approval of arrangement with TVA for supply of power, National Carbon division of Union Carbide and Carbon Corp. is considering a major expansion of its electrode plant at Columbia, Tenn. Company representatives stated that this expansion, to involve an expenditure of over $5,000,000, is being undertaken to meet growing demand for large graphite electrodes used in the steel and metallurgical industries.

Location of this expansion program in the south would be another step in the development of major industries in this section of the country.

This plant will have the most modern and efficient production facilities, resulting from National Carbon's extensive research and development activities. It is being especially designed to produce large graphite electrodes to meet present and future service demands of high-power furnace operations. Sizes will range up to and including 40 in. diameter by 110 in. long, weighing about 7000 lb each. It is expected this plant could begin producing graphite electrodes during the spring of 1951.

STANLEY WORKS BUYS SLAB HEATING FURNACE

▲ A slab heating furnace to serve a strip mill of the Stanley Works at Bridgeport, Conn., is being designed and will be built by Rust Furnace Co.

The triple-fired furnace, to burn oil, is being designed by Rust for a capacity of 50 tons per hour to deliver slabs at a temperature of 2250 F.

Dimensions of the furnace will be 20 ft wide, with a 45 ft effective length.

It will be equipped with three zone automatic temperature control and automatic furnace pressure control equipment. Plans now call for construction to begin early in the fall.

FORM NEW ELECTRIC FIRM IN CLEVELAND

▲ Hutco Electric, Inc. has been organized as a corporation under the laws of the State of Ohio to engage primarily in the business of wholesaling of electrical apparatus such as motors, control, safety switches, transformers, capacitors, lamp bulbs, wire, cable, conduit, wiring accessories, and similar equipment. Sales effort will be directed in greater Cleveland, and later in all Northern Ohio, at contractors (electrical, heating and ventilating, air conditioning, etc.), industrial concerns (both large and small), and resale manufacturers. Warehouse and office space has been leased at 3204 St. Clair Avenue, Cleveland, Ohio, and Hutco Electric, Inc. is now in the process of negotiating for cer-

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HEAT TREATING FURNACES
Indicating · Recording · Controlling
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TO IMPROVE
MANY PHASES OF
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AND TO CUT YOUR
FUEL AND LABOR COSTS.
The bulletin illustrated is not just a piece of sales literature but a complete 24 page treatise on the instrumentation and automatic control of steel making and heat treating furnaces. You'll want a copy for your reference files, want to profit from its practical, authoritative information.
And remember as you read it, Hays engineers are thoroughly qualified and ready to work hand-in-hand with you in solving your own specific instrumentation and control problems . . . without obligation.
Write for your copy today . . . Ask for Bulletin No. 48-750 (covering heat-treating furnaces). Companion edition covering open-hearth furnaces will also be included.
THE HAYS CORPORATION, MICHIGAN CITY 13, INDIANA
Steel that's better, with more uniform grain structure . . . maximum production because of continuous equipment performance . . . fewer rejects . . . lower fuel, maintenance and labor costs—these are advantages you can count on when you use Hays instruments and controls for:
Annealing
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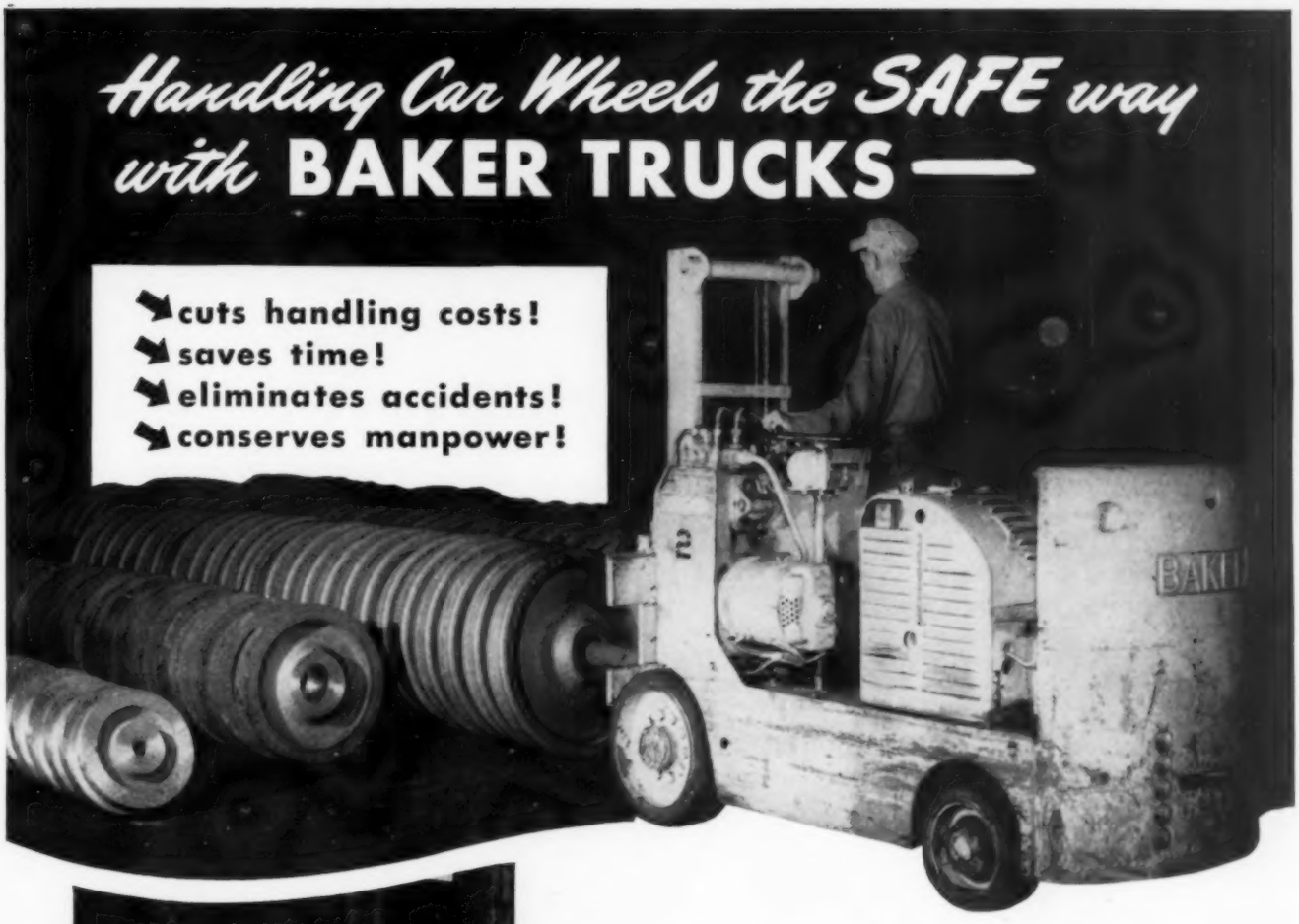
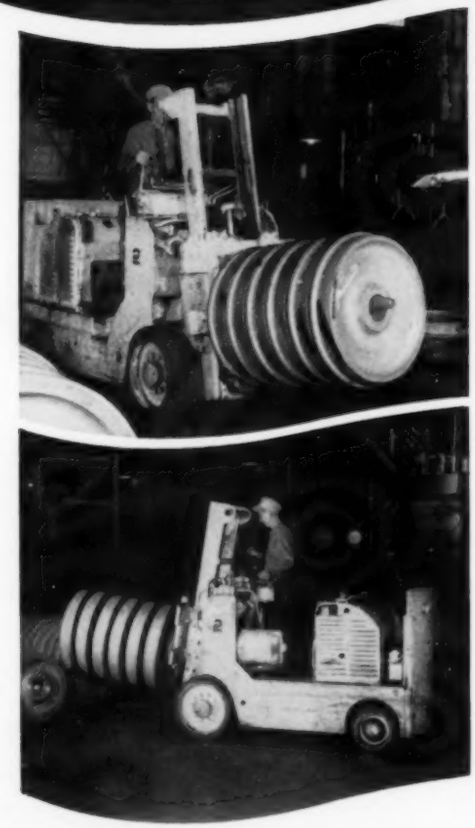
Handling Car Wheels the SAFE way with BAKER TRUCKS —





● Handling car wheels manually has always been a hazardous, costly operation. Illustrations show how one wheel manufacturing company has brought about substantial cost savings, at the same time greatly reducing lost time due to accidents, by mechanizing wheel handling with two Baker 6000 lb. Ram Trucks.

The trucks are used to handle wheels in production. Wheels are carried 6 at a time from the forging machines to the wheel turning machines where they are lined up on the floor awaiting the processing operation. When needed, they are transported to the turning machine, and as they are finished they are moved to the shipping floor, where they await loading into gondola cars by means of overhead cranes.

Wheel hauling is but one of many hazardous industrial handling operations made safe by mechanization with Baker Trucks. A Baker Material Handling Engineer is at your service to solve your specific problems.

BAKER INDUSTRIAL TRUCK DIVISION
of The Baker-Raulang Co.
1229 WEST 80th STREET • CLEVELAND, OHIO
In Canada: Railway & Power Engineering Corp., Ltd.

Baker INDUSTRIAL TRUCKS

tain desirable lines of equipment, with the expectation of commencing business on August 16, 1950.

Hutco Electric, Inc. has an unusual opportunity for success since it will offer to customers a feature new to this area. It will provide application engineering service by specially trained representatives of a quality not hitherto offered by electrical wholesalers.

John L. Hutton, who is president, was employed by the General Electric Co. for 22 years, being located in Schenectady, N. Y., from 1925 to 1930, and in Cleveland in industrial sales from 1930 to 1947. In 1947 he joined the Clark Controller Co. of Cleveland as manager of their Philadelphia district sales office, and early in 1949 was returned to Cleveland sales office as district manager. George M. Coon will also be a vice president. Mr. Coon was in the employ of Cutler-Hammer, Inc. from 1933 to 1949, doing sales work in Cincinnati, St. Louis and Cleveland. In 1949 he joined Clark Controller Co. as manager of the Akron sales office. Carlton S. Cobert, secretary-treasurer, will act primarily as general manager of office and warehouse operations. Mr. Cobert joined the Clark Controller Co. in 1933 and has since been associated with them directly and indirectly in various capacities, and early in 1949 was appointed district engineer for the Cleveland sales office. He has also been employed on a part-time basis by Reliance Electric and Engineering Co., and has been associated with a sales office representing the Pennsylvania Transformer Co., I-T-E Circuit Breaker Co. and other electrical manufacturers.

WATER CONFERENCE SCHEDULED IN PITTSBURGH

▲ The Eleventh Annual Water Conference of the Engineers' Society of Western Pennsylvania will be held on October 16, 17, 18, 1950 in the Hotel William Penn, Pittsburgh, Pa.

CLAIRTON WORKS BOOSTS COKE PRODUCTION

▲ U. S. Steel's high-geared production pace in Pittsburgh district mills got another boost August 11 with the pushing of the first coke from a new battery of by-product ovens at Clairton, Pa., works of Carnegie-Illinois Steel Corp.

The new unit annually can produce upwards of 300,000 tons of coke for steelmaking. It is the sixth battery of modern coke ovens built at Clairton since the end of the war in a continuing program of replacing old ovens in order to keep pace with the record-shattering output of the steel mills.

There are 61 modern Wilputte coke ovens in the new battery. They replace a 25 year old unit, razed a year ago after a lifetime production of ten million tons.

In addition to turning out close to 900 tons of coke a day, the new ovens will produce some 14 million cu ft of by-product gas daily for use in district steelmaking operations and large quantities of other by-products for chemical manufacturing industries.

The ovens, the second largest battery of Wilputte ovens completed this year, are of the latest design, with self-sealing doors and double collector mains which are designed to reduce smoke to an absolute minimum.

USE THE ENGINEERING MART

Announcement

The MAINTENANCE ENGINEERING CORP. has completely absorbed its associate machinery repair operation formerly known as METALOCK CORPORATION OF PENNSYLVANIA in a recent program to broaden its specialized maintenance and engineering service to industry.

The services offered by Maintenance Engineering Corporation comprise the metal insert or metal stitching service, Thermit welding, metalizing, vacuum-pressure impregnation of castings, specialized welding, specialized machine work and inspection of machinery, pressure vessels, tanks and boat hulls by electronic and supersonic instruments.

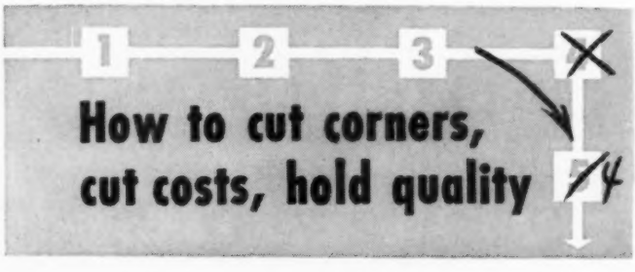
Literature and service engineers are available on request.

MAINTENANCE ENGINEERING CORP.

Office: 530 Wm. Penn Place, Pittsburgh 19, Pa.

Phone: GRant 1-9258, Day or Night

Shop: Versailles, Pa.



OAKITE metal-cleaning procedures can make an entire production operation easier, cheaper, quicker. Here are two examples:

1. Pre-Paint Treatment Saves $800 Monthly That's what an electrical manufacturer credits to the OAKITE Crys-Coat PROCESS, which simultaneously cleans and phosphates metal surfaces.

2. New Brass Cleaner Makes Big Savings A large electroplating job shop cleans brass with a new Oakite formula that minimizes tarnishing and rejects; cleans so well that, in many cases, a copper strike is dropped from the plating cycle.

FREE Write Oakite Products, Inc., 19 Thames St., New York 6, N. Y., for the new 44-page booklet *"Some good things to know about Metal Cleaning"*. Subjects:

Machine cleaning	Tank cleaning	Electrocleaning
Pre-paint treatment	Pickling	Paint stripping
Steam-gun cleaning	Burnishing	Rust prevention

Technical Service Representatives in Principal Cities of U. S. & Canada

OAKITE SPECIALIZED INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

Basic principles of lubrication govern the performance of sleeve bearings. Proper application of those principles and the innate quality of Bunting Bronze Bearings give assurance of successful operation in service. The wide experience of our engineers is at your disposal. THE BUNTING BRASS & BRONZE COMPANY, Toledo 9, Ohio. Branches in Principal Cities.
BRONZE BEARINGS
PRECISION BRONZE BARS
BUSHINGS
64
Bunting®

NATIONAL CARBON SCORES AGAIN!

ANNOUNCING NEW "NATIONAL"

STANDARD BRUSHES

at a BETTER PRICE for a BETTER PRODUCT in a BETTER PACKAGE

Our years of standardization work boil down to this: you get the grade used originally, or a newly-developed superior grade, in a new, simplified method of carbon brush purchases. You make a substantial saving in ordering, billing, stocking and transportation.

HERE ARE A FEW OF THE BRUSH ITEMS YOU CAN NOW ORDER FROM STOCK:

TYPICAL APPLICATION	BRUSH No.	SIZE (inches)	GRADE	Standard Package
● West. SK Motors & Generators	NC 12–3202	1¾ x 1 x ⅜	255	50
● GE CD Motor & Gen. (15/15°)	NC 12–4003	2 x 1¼ x ⅜	255	50
● Diesel-Elec. Loco. Main Gen. (30/30°)	NC 12–4819	2¼ x 1½ x ⅜	SA-35	100
● Diesel-Elec. Aux. Gen. & Blower	NC 16–3220	1¾ x 1 x ½	SA-3538	100
● West. Motors & Gen. (Tandem Holders)	NC 16–5603	2½ x 1¾ x .492	SA-35	100
● Diesel-Elec. Aux. Gen. & Blower	NC 20–3220	2 x 1 x ⅝	259	100
● Diesel-Elec. Main Generator	NC 20–4202	2 9/16 x 1 5/16 x ⅝ (5/16-5/16)	SA-3590	100
● P.C.C. Car Motors	NC 20–4810	2 x 1½ x ⅝ (5/16-5/16)	AX-5	100
● Diesel-Elec. Traction Motor	NC 20–6420	2⅛ x 2 x ⅝ (5/16-5/16)	AZY	100
● Diesel-Elec. Main Generator	NC 24–4024	2½ x 1¼ x ¾ (⅜-⅜)	255	100
● Diesel-Elec. Traction Motor	NC 24–5620	2 x 1¾ x ¾ (⅜-⅜)	AZY	100
● Diesel-Elec. Traction Motor	NC 24–7215	2 x 2¼ x ¾ (⅜-⅜)	AZY	100

Complete lists of standard brushes supplied on request

The term "National" is a registered trade-mark of

NATIONAL CARBON DIVISION
UNION CARBIDE AND CARBON CORPORATION
30 East 42nd St., New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

ORDER BY "NC"
STANDARD BRUSH NUMBER

Personnel News...

James M. Stapleton has been appointed assistant to vice president blast furnaces, Carnegie-Illinois Steel Corp., with headquarters in Pittsburgh, Pa. Prior to his new appointment, Mr. Stapleton was division superintendent of blast furnaces at South works of Carnegie-Illinois. All of his service with the company was at South works, with the exception of two years in the company's Chicago offices and one year as superintendent of blast furnaces at U. S. Steel's Geneva Steel Co. plant in Utah.

William F. McConnor was elected executive vice president of National Tube Co., Pittsburgh, Pa. **H. J. Wallace** was named vice president in charge of sales, succeeding Mr. McConnor in that position. Mr. McConnor has been with the National Tube Co. since 1917, serving in various capacities in the operating, engineering and sales departments. For ten years prior to becoming vice president in charge of sales in 1946, he served as general manager of sales. Before joining the sales department of the company, he held important operating positions, including that of assistant to vice president, operations. Mr. Wallace has been general manager of sales since 1946. A native of Pittsburgh, he started with the company in 1928 as a laborer at the Ellwood City, Pa., plant. He joined a National Tube student training course at the Lorain, Ohio, plant in 1929 and then served as field engineer in the Pittsburgh sales division until 1933. Following this, he was employed in a sales capacity at Indianapolis and Pittsburgh until 1937, at which time he was made manager of sales of the Pittsburgh district office.

John N. Hornak was named division superintendent, steel producing for Carnegie-Illinois Steel Corp., Duquesne, Pa. Mr. Hornak who started at the Homestead, Pa., works as a laborer in 1923 was formerly assistant division superintendent, open hearths, at the Duquesne plant.

Lee O. Witzenburg was appointed general sales manager of the Cleveland Worm and Gear Co. and its subsidiary, Farval Corp. Mr. Witzenburg is a graduate of the University of Nebraska, with degrees in electrical engineering and business administration. He brings to his new position a broad experience in the field of power transmission, having been sales manager of the V-belt division of the Gates Rubber Co., and more recently sales manager of the Tann Corp.

Milton L. Weislogel was appointed assistant to general superintendent of the Gary, Ind., steel works of Carnegie-Illinois Steel Corp. **Frank A. Kelly** was named plant industrial engineer, succeeding Mr. Weislogel.

Lemuel B. Hunter has been made industrial relations manager of Inland Steel Co. succeeding **William G. Caples,** who was elected president of Inland Steel Container Co., an Inland subsidiary. Mr. Hunter has been manager of the raw materials department which has charge of the company's iron ore and coal mining properties, limestone quarrying subsidiary and fleet of Great Lakes ore carriers. **Carl B. Jacobs,** fleet manager, was named to succeed Mr. Hunter as raw materials manager.

Neele E. Stearns, executive vice president of Inland Steel Products Co., was made president of that Inland Steel Co. subsidiary. **William G. Caples,** acting vice president in charge of Inland Steel Container Co. (subsidiary of Inland Steel Co.), was elected president.

George M. Burrier has been appointed assistant general superintendent, Crucible Steel Co. of America, Midland, Pa. Mr. Burrier was formerly superintendent of open hearths at Republic Steel Corp., Corrigan-McKinney works at Cleveland, Ohio. Previously, he had been open hearth superintendent at Republic's Chicago, Ill., plant.

Lawrence F. Black has been appointed general superintendent of the Geneva plant, Geneva Steel Co. Mr. Black formerly was assistant chief engineer of the American Steel and Wire Co., Cleveland, Ohio.

C. J. Stakel, general manager of the Cleveland-Cliffs Iron Co., is retiring from that position but will continue to serve in a consulting capacity. **W. A. Sterling** has been elected a vice president of the company and will be located at the company's executive offices in Cleveland, Ohio. Mr. Sterling has been serving as manager of the Mesabi Range properties. **C. W. Allen** has been appointed general manager of iron ore operations on both the Marquette and Mesabi ranges. **Grover J. Holt** succeeds Mr. Sterling as manager of the Mesabi range properties.

JAMES M. STAPLETON

WM. F. McCONNOR

JOHN N. HORNAK

L. O. WITZENBURG

DO YOU KNOW..

That it's possible

TO GO THROUGH MANY HEATING SEASONS WITHOUT UNIT HEATER MAINTENANCE EXPENSE, providing yours is a GRID installation? GRID Units installed in steel mills in 1933 are still operating at peak efficiency. The steel mill operators do not recall having spent maintenance time on them. This performance is possible because:

GRID high test cast iron construction withstands corrosive fumes.

GRID wide fin spacing facilitates easy cleaning.

GRID will withstand steam pressures up to 250 lbs., and is free of electrolysis.

GRID fins are cast integral with the steam chamber assuring even distribution of heat. It's not possible for GRID fins to come loose from the steam chamber to cause loss of heating efficiency.

GRID design incorporating proper fan sizes, motor speeds and outlet temperatures results in a properly balanced heating unit, especially when high steam pressures are used.

No other unit heater incorporates these features that are vital to proper and efficient steel mill heating.

Investigate today GRID systems of high pressure unit heaters, blast coils, and radiation . . . the answer to maintenance-free heating in the steel industry.

D. J. MURRAY MANUFACTURING CO.
WAUSAU WISCONSIN

Ralph W. Dickson has been made division superintendent of the central mills, Carnegie-Illinois Steel Corp., Gary, Ind. Mr. Dickson has been associated with Gary works since June, 1927. He began as a metallurgical laboratory helper and has advanced through several operating jobs to his present position.

Otto A. Clarke, formerly rail mill superintendent, has been made assistant central mills division superintendent at Gary, Ind., works of Carnegie-Illinois Steel Corp. Mr. Clarke has been associated with the plant since June, 1916. He started as a wireman in the electrical department.

Richard Lenahan has been made rail mill superintendent, Gary, Ind., works, Carnegie-Illinois Steel Corp. succeeding Mr. Clarke. Mr. Lenahan has been associated with Gary works since June, 1930, starting as a temperature recorder in the metallurgical department. His most recent position was assistant superintendent of the rail mill rolling division before promotion to head the rail mill.

Ralph E. Holmes was named manager of Cincinnati, Ohio, district of Republic Flow Meters Co. The Cincinnati office is located at 3197 Linwood Ave., Cincinnati 8, Ohio.

Gerald F. Twist was elected a vice president of the Food Machinery and Chemical Corp., San Jose, Calif.

GERALD F. TWIST

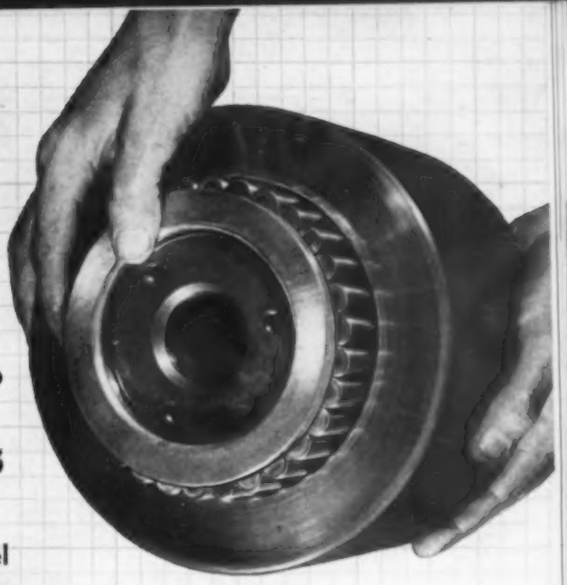
Mr. Twist has been manager of the Peerless Pump division with major plants located at Los Angeles and Indianapolis.

Charles C. Leader has been named as staff assistant to the manager of engineering of the General Electric Co.'s large apparatus divisions. Mr. Leader has been assistant to the manager of manufacturing of the control divisions.

Edison C. Sickman, formerly Baltimore district sales manager, has been appointed general sales coordinator for Atlas Mineral Products Co., Mertztown, Pa.

John P. Conde was made advertising and sales promotion manager of the Brady-Milwaukee division of W. H. Brady Co., Chippewa Falls, Wis. Mr. Conde was formerly advertising manager of Askania Regulator Co.

Frank B. Rackley, formerly executive vice president of the Jessop Steel Co., Washington, Pa., was elected president of the company. Mr. Rackley joined the Jessop firm in June, 1948, as general manager of sales. He was made vice president in charge of sales in Octo-



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USE TORRINGTON BEARINGS

It takes tremendous pressure to reduce cold strip steel 30 to 50% in one pass on thicknesses of .010" and less to close tolerances.

Sendzimir cold strip mills, engineered by Armzen Company, do it by using small diameter work rolls, rigidly backed by precision Torrington Bearings through the intermediate rolls. These bearings carry the tremendous loads and allow the mill to start and stop without resetting the gage.

Your equipment, too, will duplicate such results under heavy working loads if Torrington Bearings are used. Torrington engineers will gladly help you adapt them to your specific requirements.

THE TORRINGTON COMPANY

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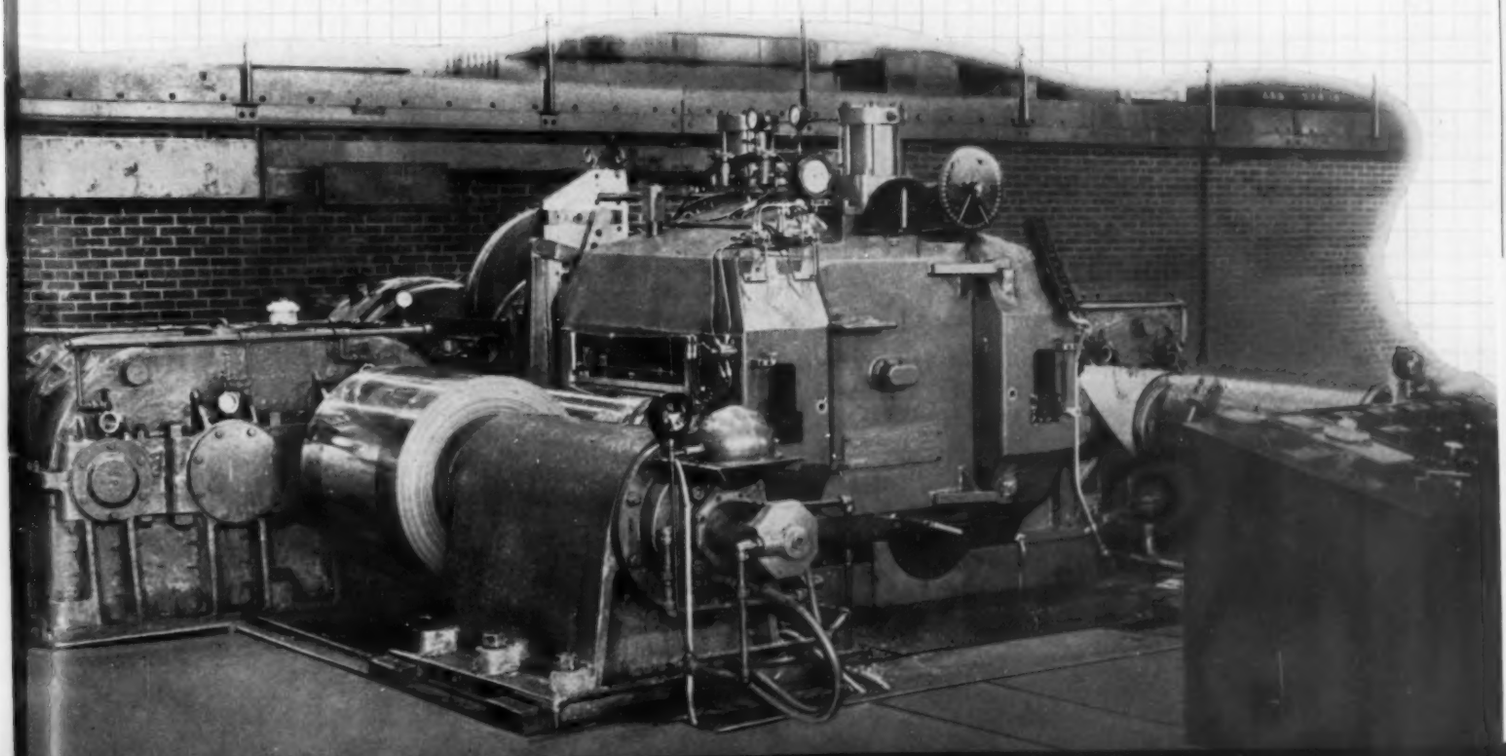
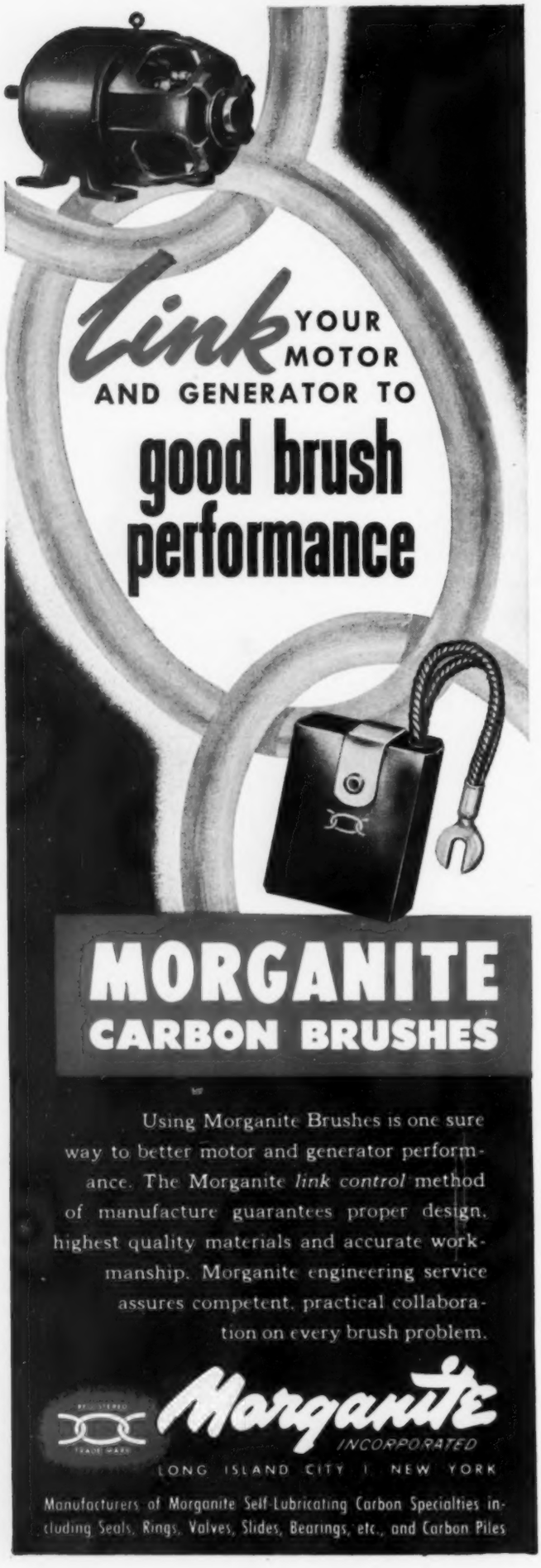
SPHERICAL ROLLER
TAPERED ROLLER
STRAIGHT ROLLER
NEEDLE
BALL
NEEDLE ROLLERS

TORRINGTON BEARINGS

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CARBON BRUSHES
Using Morganite Brushes is one sure way to better motor and generator performance. The Morganite *link control* method of manufacture guarantees proper design, highest quality materials and accurate workmanship. Morganite engineering service assures competent, practical collaboration on every brush problem.
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Manufacturers of Morganite Self-Lubricating Carbon Specialties including Seals, Rings, Valves, Slides, Bearings, etc., and Carbon Piles

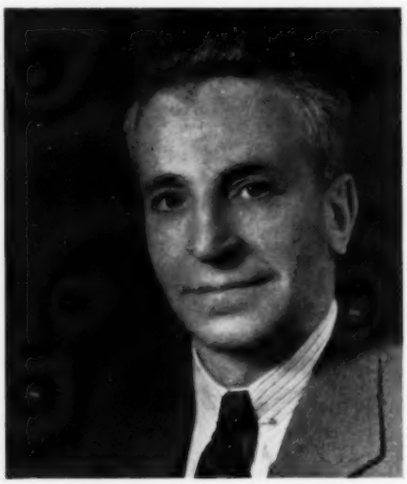
ber, 1948, and executive vice president in May, 1949. Prior to joining the Jessop Steel Co., Mr. Rackley was manager of stainless sales for the western area of the Carnegie-Illinois Steel Corp.

Dr. E. W. Volkmann and **Dr. F. L. Jones** were appointed assistant managers of the research department, Koppers Co., Inc. Dr. Volkmann has been assigned responsibility for the laboratory and development sections of the Koppers research department. Dr. Jones will supervise the research administration and patents sections of the research department.

Edward W. Addis was appointed to the sales staff of Gordon & Kinney, Inc., Detroit, Mich., representative for Automatic Transportation Co., Mr. Addis comes to the firm from Rowe Methods, Inc. where he was sales manager.

H. W. Osborne has been appointed as construction purchasing agent for Ford Motor Co. Mr. Osborne joined the Ford Motor Co. 2½ years ago, after serving with Great Lakes Steel Corp. for 19½ years.

J. David Wright has been appointed assistant manager of the General Electric Co.'s industry divisions at Schenectady, N. Y. He will be replaced in his former position as manager of the company's industrial engineering divisions by **Frederic M. Roberts. Leonid A. Umansky** will assume the post of manager of engineering of the industrial engineering divisions.



LEONID A. UMANSKY

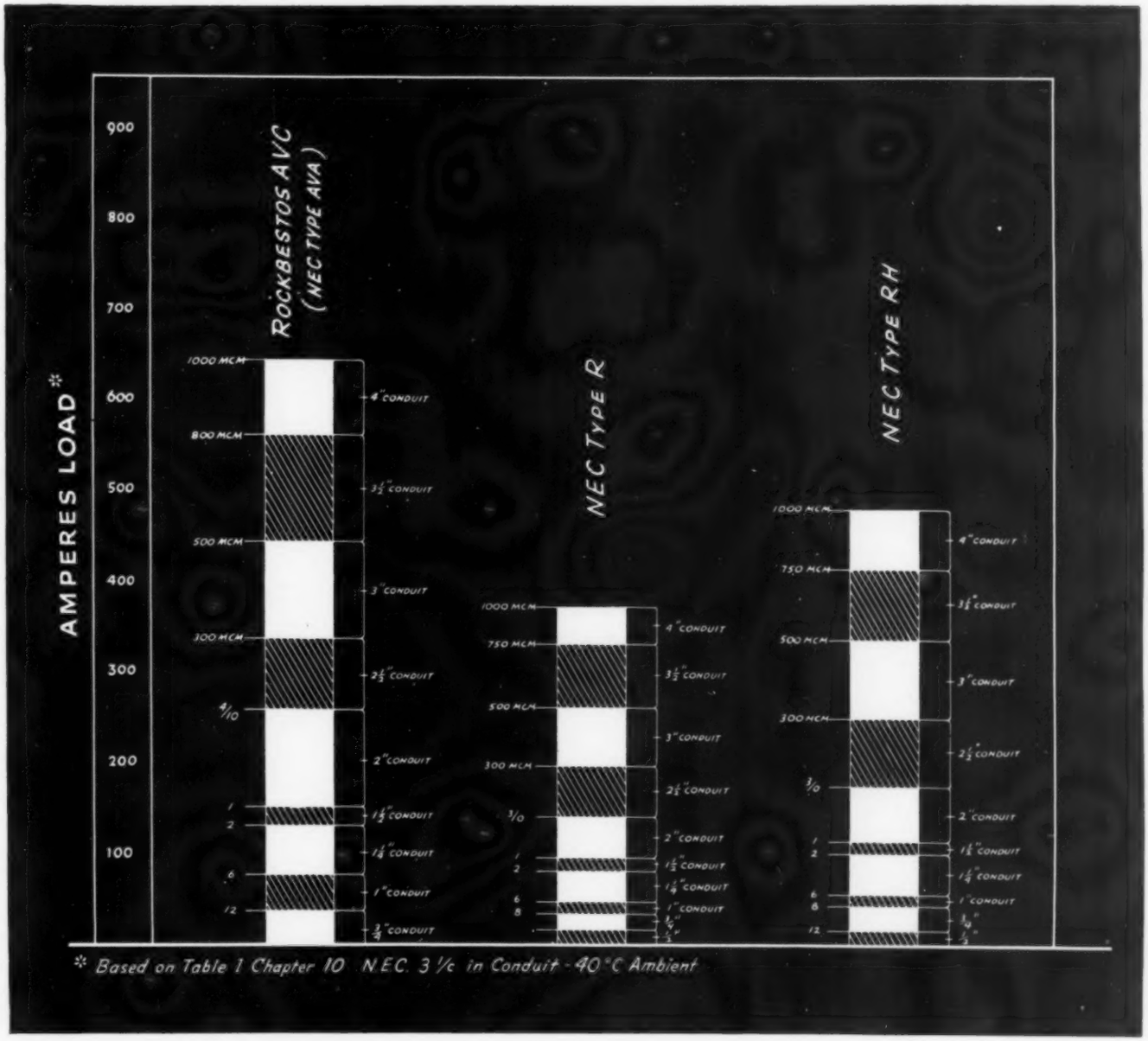
M. W. Heinritz, formerly vice president of Gould Storage Battery Corp., was elected vice president in charge of industrial sales of Gould-National Batteries, Inc.

John B. Powell has been appointed manager of the engineering division of General Electric's apparatus department New England district. Succeeding **George H. Jump** who has been appointed engineering consultant for the district, Mr. Powell will be located at the company's New England headquarters, 140 Federal St., Boston, Mass.

Edward A. Green has been appointed staff assistant to the general sales manager of General Electric's small apparatus divisions with headquarters at Lynn, Mass. He will be replaced in his former position as manager of sales of the company's control divisions by **L. Dean Fowler.**

F. W. Niggemyer, formerly of Heyl and Patterson, Inc., was named sales manager of McDowell Co., Inc., Cleveland, Ohio.

Are Electrical Loads Outgrowing Your Conduit?

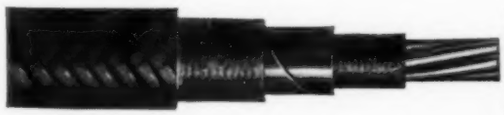


Here's the fast, inexpensive way to take care of electrical loads that have outgrown their conduits — just replace present cable with Rockbestos A.V.C. . . . *with Rockbestos A.V.C. you can increase conduit capacity without increasing conduit size.*

Use A.V.C. whenever load growth outruns present wiring. With it you can easily increase capacity without buying and installing larger conduit or fittings. Write today for the booklet "Rx for a Building with Hardening of the Electrical Arteries."

ROCKBESTOS PRODUCTS CORPORATION
NEW HAVEN 4, CONN.

NEW YORK CLEVELAND DETROIT CHICAGO
PITTSBURGH ST. LOUIS LOS ANGELES OAKLAND, CAL.



ROCKBESTOS A.V.C.
has a HIGHER AMPERE RATING

Roy Comstock was named electrical engineer for O. Z. Electrical Mfg. Co., Inc., Brooklyn, N. Y. Mr. Comstock was formerly associated with Cutler-Hammer, Inc., in a sales and engineering capacity.

George H. Kinzel was named sales manager of O. Z. Electrical Mfg. Co., Inc., Brooklyn, N. Y. Mr. Kinzel will devote much of his time in his new connection to traveling with wholesalers' representatives. Mr. Kinzel was formerly sales manager of the Bergen Wire & Rope Co., and sales manager of the engineered products division of Air Associates, Inc. Prior to that he was sales supervisor in the Eclipse-Pioneer division of the Bendix Aviation Corp.

R. J. Matteson has been appointed district manager of Askania Regulator Co.'s New York office. He succeeds **W. F. Pray** who died April 16, 1950. Mr. Matteson is a graduate of University of Wisconsin, school of mechanical engineering, and was associated with Superheater Co. before joining Askania.

Howard B. Myers, formerly technical director for the Roll Manufacturers Institute, Pittsburgh, Pa., accepted a position as metallurgical engineer for the S. H. Bell Co., Pittsburgh, where he will be engaged in selling ferro-alloys and pig iron produced by the Tennessee Products and Chemical Corp.

Dr. Robert H. Steiner has been appointed as research coordinator for Atlas Mineral Products Co., Mertztown, Pa. Dr. Steiner has been employed by Firestone Tire and Rubber Co. for the past seven years.

Leonard E. Bees has been appointed vice president in charge of manufacturing of Trumbull Electric Manufacturing Co. in Plainville, Conn. Mr. Bees had been manager of manufacturing since August 1949.

Grant A. Colton was elected vice president and general manager of Golden-Anderson Valve Specialty

GRANT A. COLTON

Co., Pittsburgh, Pa. Mr. Colton has served as assistant manager of the company since 1934.

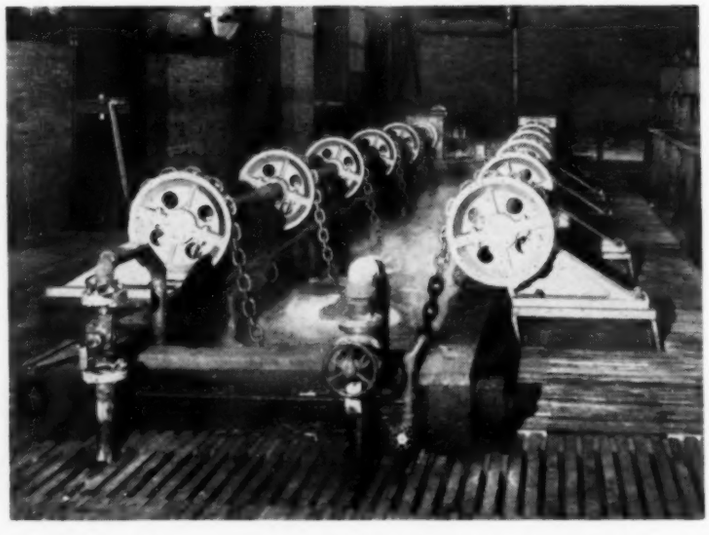
Alton H. Lundius has been appointed works manager in charge of all manufacturing and service opera-

"First things come first," states an old saying, and that's why this Weldco Mechanical Pickler is an important addition in the Cold Drawn Division of an Eastern Ohio steel mill. For the success of the cold-drawing operation depends on the proper pickling of the bars, and this pickling-descaling job comes "first."

The Pickler shown here is a 7½-ton Mechanical Bar Pickler in a floor-level tank 5' x 5' x 43'. This equipment pickles 120 tons per turn—rounds, squares, hexagons, and flats. The spreaders, chains, and foundation bolts are made of long-lasting, corrosion-resisting Monel.

Production records in this Ohio steel plant show

Cuts Pickling and Drawing Costs



In Major Ohio Steel Plant

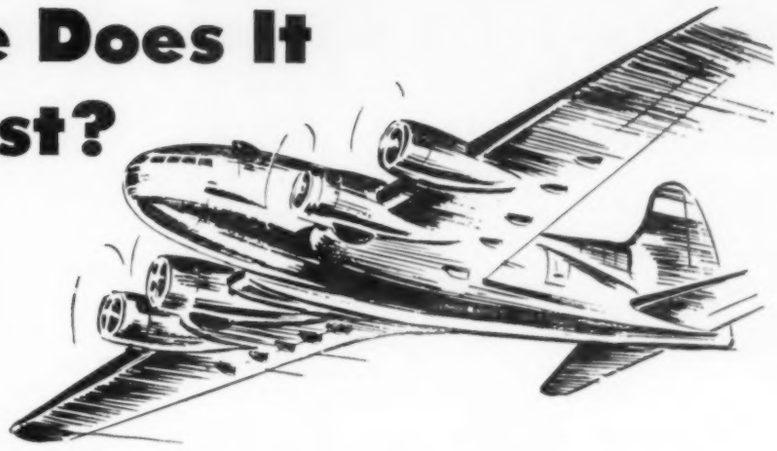
a uniform, complete descaling operation, reduced pickling and drawing costs, longer die life, and fewer rejects at the drawbench . . . . all of which indicate a sound investment in pickling equipment that will soon pay for itself.

Weldco Mechanical Picklers are also available for pickling coils, tubing, and sheets . . . can be built to any capacity. Write today for complete information and descriptive literature.

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY

3700 OAKWOOD AVENUE . . . YOUNGSTOWN 9, OHIO

Which Engine Does It Need the Most?



The airplane needs all four engines, obviously. And so it is in Steel Mill Lubrication Systems—all four fundamentals of design must be rigidly adhered to. De Laval engineers understand this and on every mill lubrication job entrusted to them emphasize each of the following basic requirements:

★
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PURIFICATION OF LUBRICATING OIL

De Laval Oil Purifiers, furnished as part of the design where possible, are permanently piped to the system to permit centrifugal by-pass purification of the lubricant in service. The Purifiers remove water and fine solid contaminants.

PROPER SELECTION OF PIPE SIZE

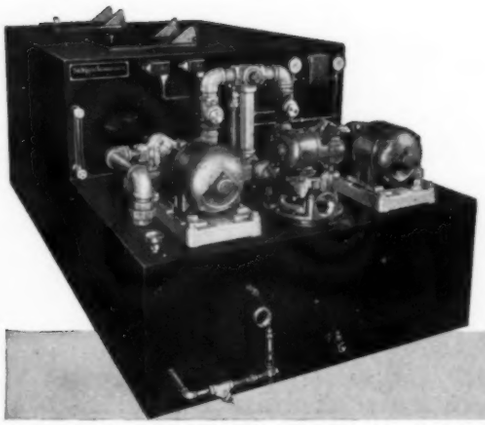
The proper selection of pipe size is important to provide efficient lubrication. All De Laval Systems are designed to keep the pressure drop due to line friction at a minimum, and to insure a streamline flow.

CORRECT METERING OF LUBRICANT

De Laval Systems stress supplying each bearing and gear mesh point with exactly the right amount of lubricant. A constant streamline flow of lubricant in the correct quantity and pressure must be maintained at all times.

EFFICIENT TEMPERATURE CONTROL

De Laval Systems incorporate a constant control of the lubricant temperature both winter and summer. By the use of efficient heating or cooling facilities, a continuous flow of lubricant at the correct temperature and viscosity is maintained.



THE DE LAVAL SEPARATOR COMPANY
165 Broadway, N. Y. 6 427 Randolph St., Chicago 6
DE LAVAL SALES & SERVICE, INC.
447 Fourth Ave., Pittsburgh 19
DE LAVAL PACIFIC COMPANY
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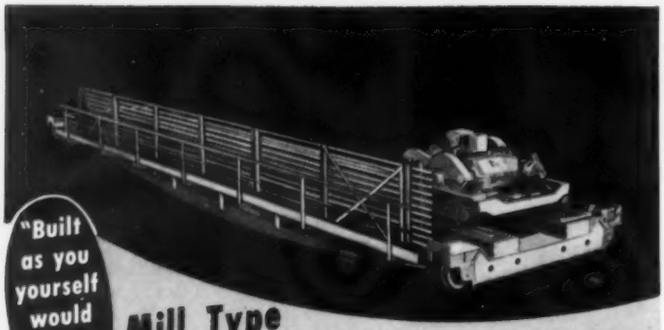
DE LAVAL

ENGINEERED SYSTEMS



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Mill Type Cranes BUILT BY Browning

HAVE *Strength* WHEREVER STRENGTH IS NEEDED

Satisfying A.I.S.E. specifications, Browning Mill Type Cranes incorporate types of motors and controls on which you have standardized. This flexibility suits your VRB crane *perfectly* to your needs. Our design, springing from 49 years' experience, places plenty of strength where it is required.

Ask for our Bulletin "S".

Husky 10-ton mill type trolley equipped with separate load girt for easy removal.

VICTOR R. BROWNING & COMPANY, Inc.
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

MR. BLAST FURNACE SUPERINTENDENT:

YOU WILL EXPERIENCE FEWER SHUTDOWNS, CONSEQUENTLY GREATER PRODUCTION . . . IF YOU SPECIFY AND ORDER:

- FALCON COOLING PLATES, both Bosh and Inwall – because they are made without those leak producing anchors and chaplets.
- FALCON PLATES are all cast without anchors and chaplets – one homogeneous casting with uniform wall thicknesses.

FURTHERMORE, THEY ARE CAST VERTICALLY WHICH INSURES THE DENSEST, MOST SOLID POSSIBLE METAL, IN THE NOSES . . . . . .

- FALCON PLATES are free from sand inclusions and metal oxides.
- FALCON BAFFLE ARRANGEMENTS provide maximum circulation of cooling water and the elimination of sediment deposits.
- FALCON PLATES provide maximum cooling capacity because they contain no pockets in which gas and air can accumulate.

INSIST ON FALCON ANCHORLESS COOLING PLATES

Falcon delivery and quality will exceed your expectations. It is based on sixty continuous years of "know-how."

Telephone Collect 3-4186
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YOUNGSTOWN 3, OHIO
Established 1890 - Incorporated 1895

tions for Hyatt Bearings Division of General Motor. Corp. at the Harrison and Clark Township, N. J., plants. **Robert R. Guempel** has been appointed plant manager of the Clark Township plant. **William H. Chapman** has been appointed director of engineering to coordinate machine and product design, research and application engineering. **Martin A. Moore** has been appointed administrative assistant to the general manager. **David B. Caminez** has been appointed divisional comptroller.

Harry T. Graham was appointed as general sales manager of General Refractories Co., Philadelphia, Pa. Mr. Graham has been in the employ of the company since 1937 with field sales assignments in the Chicago, Philadelphia and Pittsburgh district offices. Since September 1, 1949, he has been assistant general sales manager.

Robert H. Whitehill, former manager of Clark Controller Co.'s Pittsburgh office, was named manager of the Cleveland district sales office. **H. B. Stallings,** previously Buffalo manager, has been appointed manager of the Pittsburgh district. **Harry M. Cook** of the Birmingham, Ala., office is named district manager of the Buffalo area. **William R. Heckman** moves from Syracuse, N. Y., to be manager of the Akron office. **John D. Puette,** for the past year manager of industrial sales, in the Cleveland home office, becomes district engineer in the Cleveland sales office. **John W. Fox** is named manager of applied engineering in the home office.

C. C. Clymer has been appointed manager, materials handling and testing equipment division of General Electric's industrial engineering divisions, Schenectady, N. Y. Mr. Clymer is replacing **M. A. deFerranti,** who has been appointed assistant to the manager, parts division, aircraft gas turbine divisions.

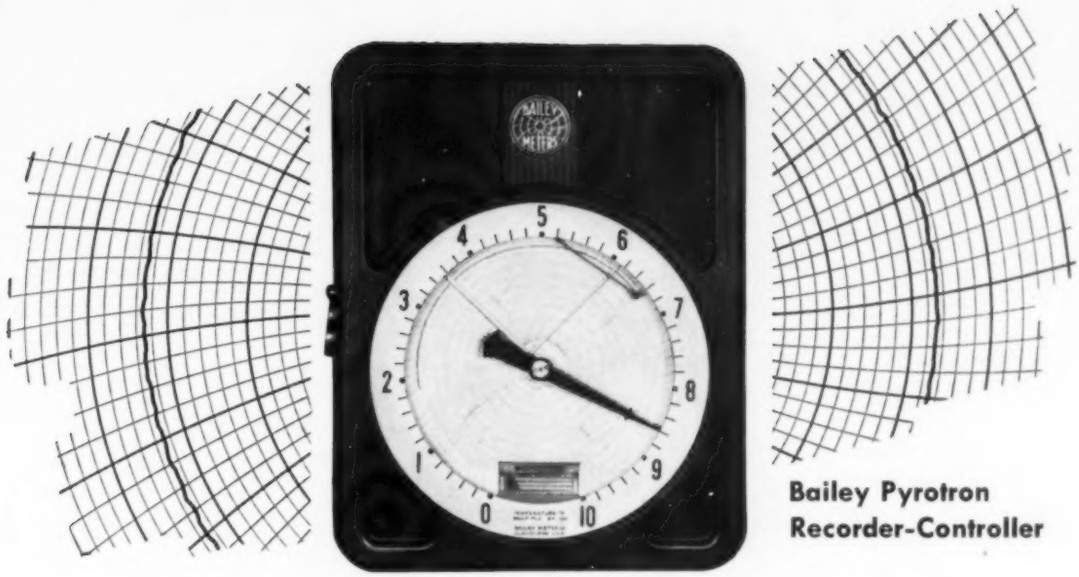
Obituaries

Robert Ross Wason, 62, president, Manning, Maxwell & Moore, Inc., died July 7.

Clyde E. Cochran, 72, an engineer for 44 years for Elwell-Parker Electric Co., Cleveland, Ohio, recently passed on at Twinsburg, Ohio. He was director of engineering when he retired in 1946.

Arthur H. Timmerman, 79, nationally known veteran of the electrical industry and until March of this year a vice-president of Wagner Electric Corp., died in Dallas, Tex., July 18. Mr. Timmerman's industrial career began in 1899, when he joined the Wagner company. He was chief engineer from 1908 to 1919 when he became vice-president, and in 1925 he was elected a director. He retired March 20, 1950 after fifty years with the company.

USE THE
ENGINEERING MART



Bailey Pyrotron
Recorder-Controller

Looking for Better Temperature Instruments?

. . . Then check these features of Pyrotron Electronic Resistance Thermometers . . .

FUNDAMENTAL ACCURACY

Bailey Pyrotron Resistance Elements are made of highest purity platinum—the material used by the National Bureau of Standards in establishing basic standards for temperatures from −190°C to +660°C.

THREE TYPES OF CONTROL

Pyrotron Controllers may operate: on-off electrical systems by either electronic relays or electric contacts, modulated electronic systems, or air-operated systems. Two temperatures may be recorded on the same chart and controlled by a single instrument.

FACTS PUT INTO USABLE FORM

Bailey Pyrotrons may be arranged to put temperature facts into convenient usable forms. If two or more temperatures are related, they may be recorded as continuous records on the same chart for easy comparison. The average of several temperatures or the difference between two temperatures may be recorded as a single continuous record which may be retransmitted to a distant point or used to actuate a control system.

EASY INSTALLATION

Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

MINIMUM MAINTENANCE

The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

ABUNDANT POWER

A separate motor drive for each temperature furnishes abundant power to operate a recording pen, a controller and an alarm switch.

For the full story on this unusual electronic resistance thermometer which is suitable for ranges between −300°F and 1200°F, ask for Bulletin No. 230-C. P-21

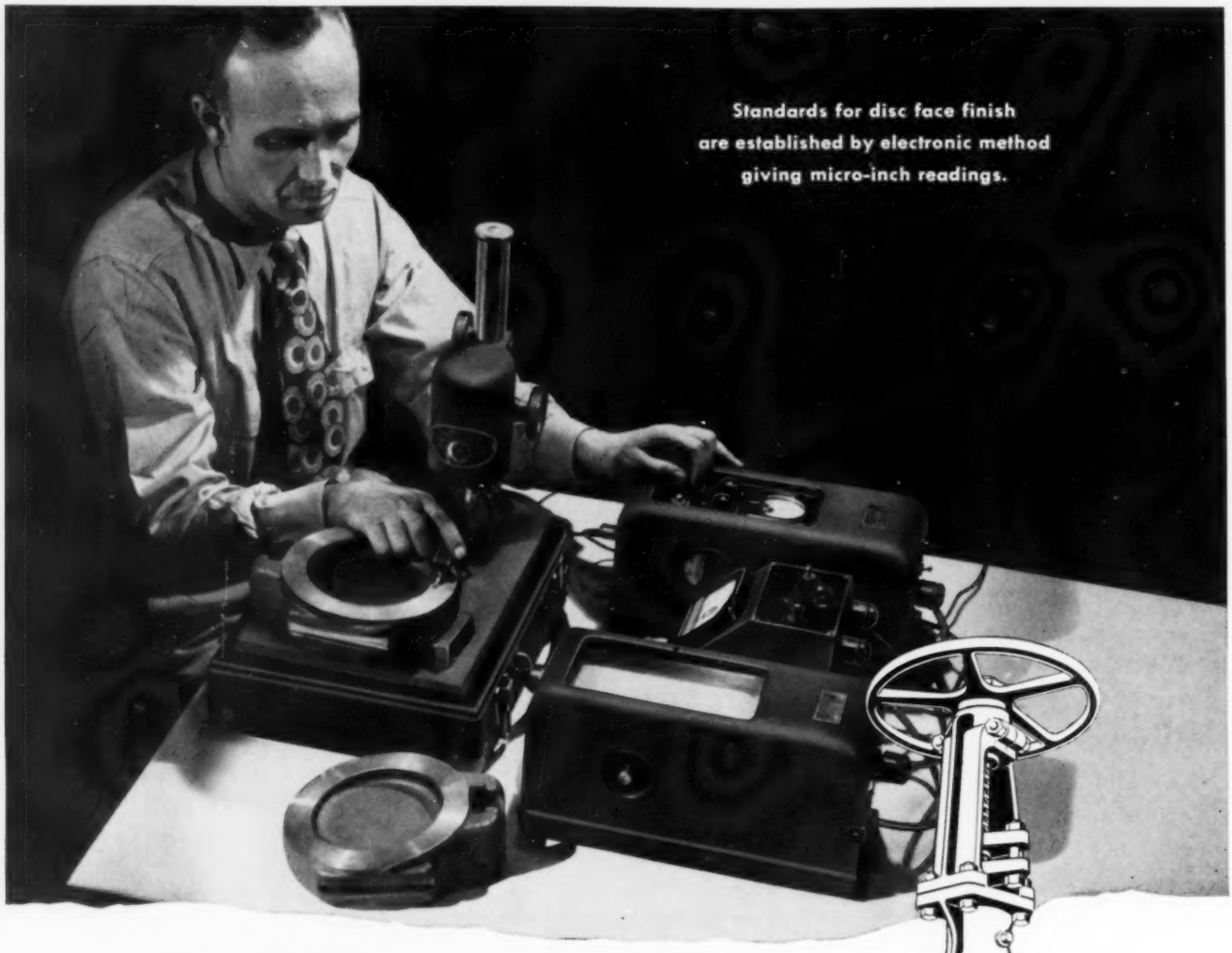
BAILEY METER COMPANY

1047 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE FLOW
PRESSURE LEVEL
% OXYGEN DENSITY
% COMBUSTION RATIO

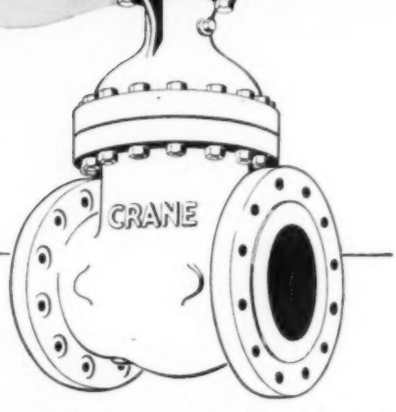
More **CRANE VALVES** are used than any other make



Standards for disc face finish
are established by electronic method
giving micro-inch readings.

How CRANE controls quality to the Micro-Inch to cut your valve costs

Surface finish of a valve's working parts has a lot to do with its wear resistance and operating efficiency. A correct finish means a tighter-seating valve, easier operation, greater ease of maintenance. In Crane Quality valves, the surface finish of machined parts is measured and controlled to rigid limits. The standards for quality control of surface finish are determined by the most scientific methods as shown above. Yes, nothing is overlooked to make Crane Valves the lowest-cost valves in the long run. *That's Crane Quality!*

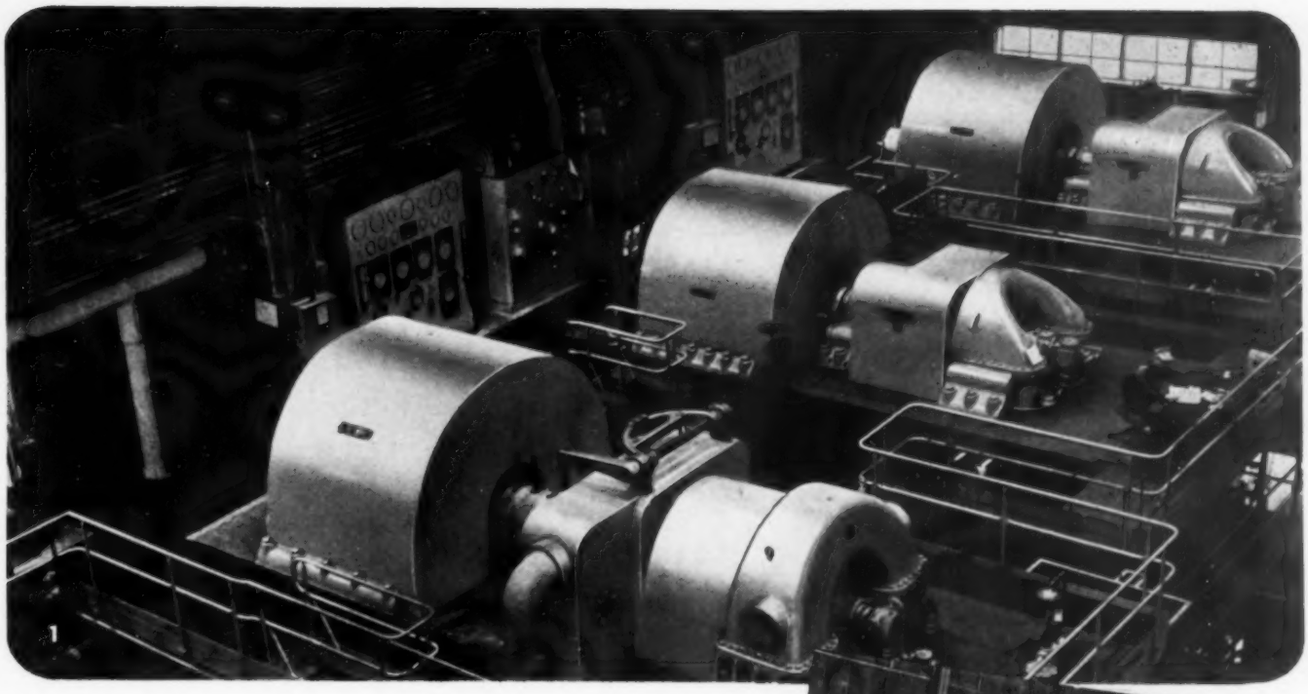


Precise quality control of materials, design, and manufacturing—to the highest degree in the industry—makes Crane valves the lowest cost valves in the long run. On steam service, oil and oil vapor lines, for example, you'll find Crane Steel Gate Valves a sure remedy for high maintenance costs. Talk it over with your Crane Representative.

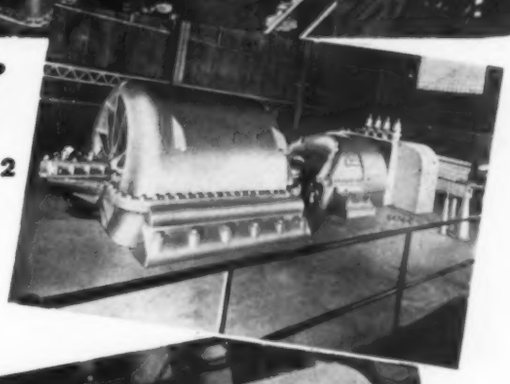
CRANE VALVES

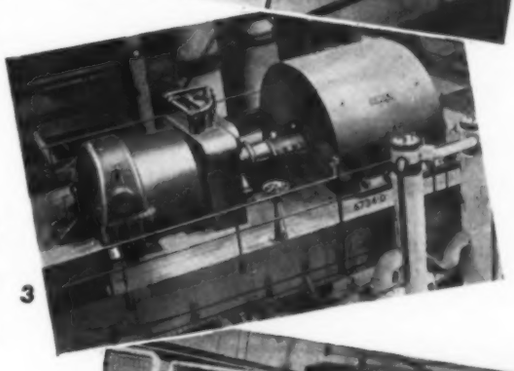
CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

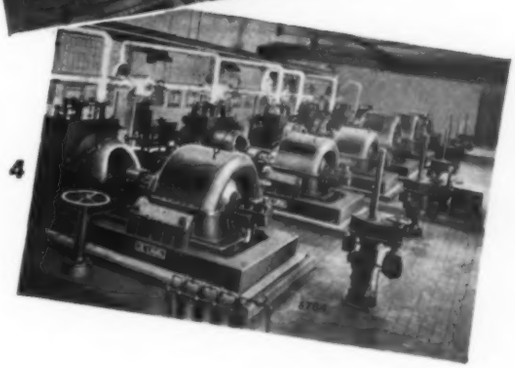
VALVES • FITTINGS • PIPE • PLUMBING • HEATING



DE LAVAL BLOWERS SERVE AMERICA'S LEADING STEEL PRODUCERS







Carnegie-Illinois, Jones & Laughlin, Pittsburgh Coke & Chemical, Wheeling Steel, Great Lakes Steel, Pittsburgh Steel, Lone Star Steel, Steel Company of Canada, Canadian Furnaces, Ltd. and others—all use De Laval blowers.

1. **At the Edgar Thomson Works** of the Carnegie-Illinois Steel Corp. The most recent of three De Laval turbine-driven blowers is the unit in the foreground. This blower is rated at 123,000 cfm at 33.3 psig (equivalent at standard conditions) and is driven by a 13,900 hp turbine designed for operation at 650 psig.

2. **At the Aliquippa Works** of the Jones & Laughlin Steel Corp. One of two De Laval 100,000 cfm blowers driven by an 11,110 hp De Laval turbine.

3. **At the Gary Steel Works** of the Carnegie-Illinois Steel Corp. One of three 110,000 cfm De Laval blowers driven by a 12,350 hp De Laval turbine.

4. **Six more De Laval turbine-driven blowers** at Aliquippa Works of the Jones & Laughlin Steel Corp.

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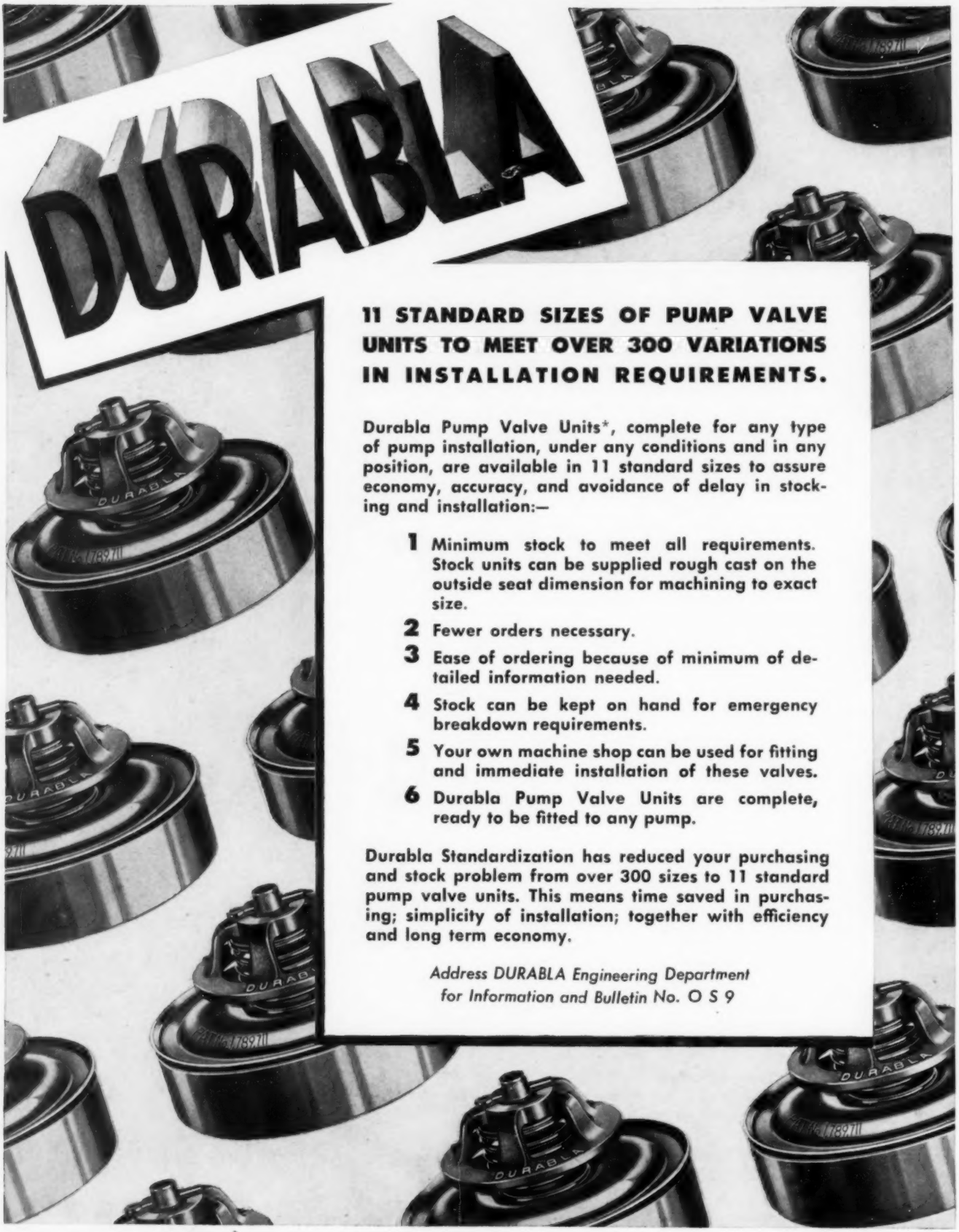
DE LAVAL **DE LAVAL STEAM TURBINE CO.** Trenton 2, N. J.

C-13



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5. Your own machine shop can be used for fitting and immediate installation of these valves.
6. Durabla Pump Valve Units are complete, ready to be fitted to any pump.

Durabla Standardization has reduced your purchasing and stock problem from over 300 sizes to 11 standard pump valve units. This means time saved in purchasing; simplicity of installation; together with efficiency and long term economy.

Address DURABLA Engineering Department for Information and Bulletin No. O S 9

*Patent Numbers 2090486, 2117504

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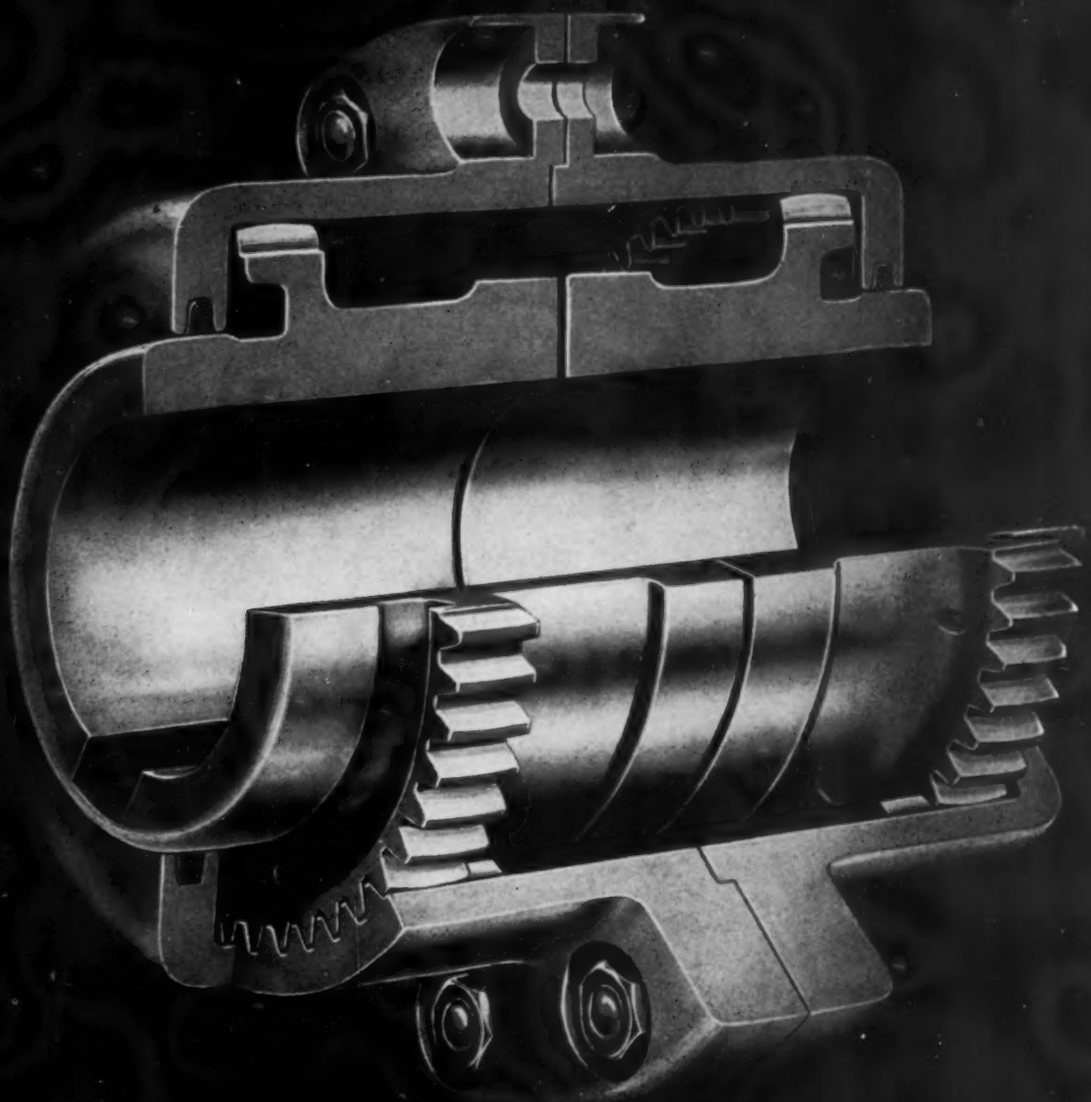
POOLE



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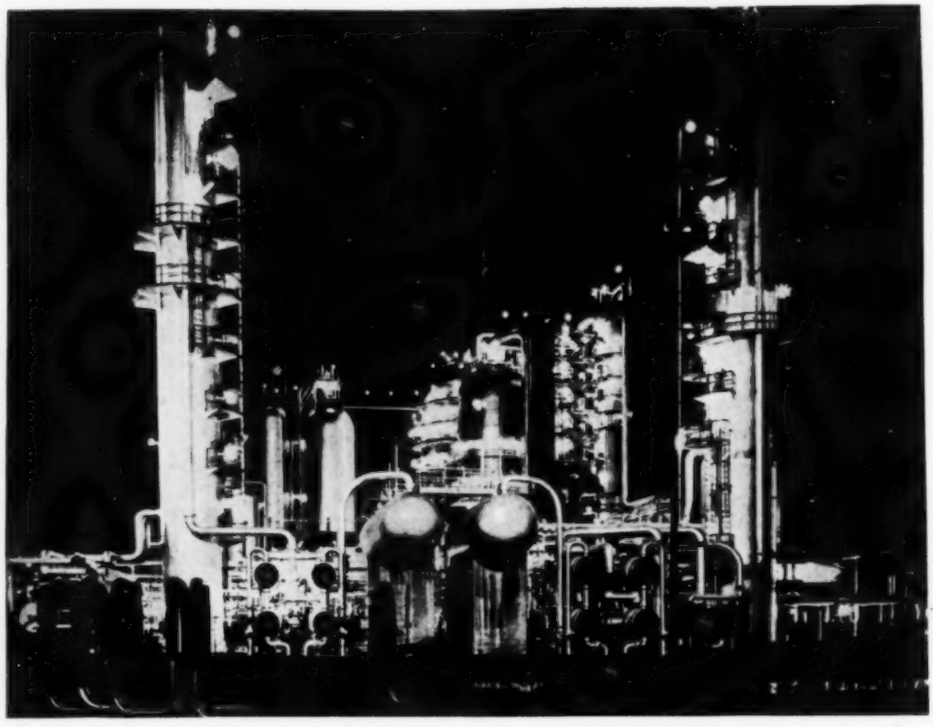

New!

1000 watt *Refractolens UNIT No. U-850.** Ideal for a wide variety of outdoor locations. May be mounted against wall or recessed. Refracts the light downward at about 65° and spreads it laterally through 180°. For uniform illumination, space about four times the height above ground. This Refractolens unit is built to withstand heat, shock and weather. Rugged cast aluminum alloy housing has hinged door for access to lamp.

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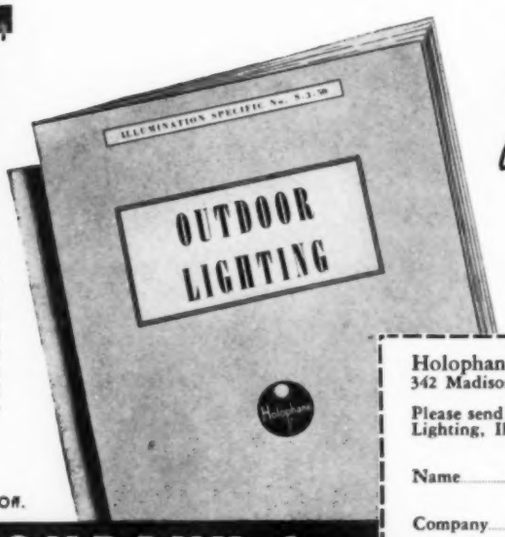
Write for the Latest Holophane Book on Outdoor Lighting . . . This important publication backed by 50 years of experience in the field, gives authoritative information and recommendations as to the units best suited for any particular application. It also includes diagrams and practical suggestions on spacing, mounting height, footcandles and other pertinent data.



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This plant's experience is typical of that of thousands of other users, and tells why Homestead Lever-Seald Valves have been first choice for more than 18 years for services where corrosive fluids, slurries, abrasives, or extremes of temperature or pressure cause ordinary valves to fail.

Homestead Lever-Seald Valves are stick-proof; require less maintenance; and the means for easy turning under all conditions, is built right into the valve. We can furnish them in stainless steel, steel, iron, brass or alloys to meet your needs; sizes 1½" to 10"; for pressures from vacuum to 1500 lbs.

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Get in ALL Your Scrap---Profitably

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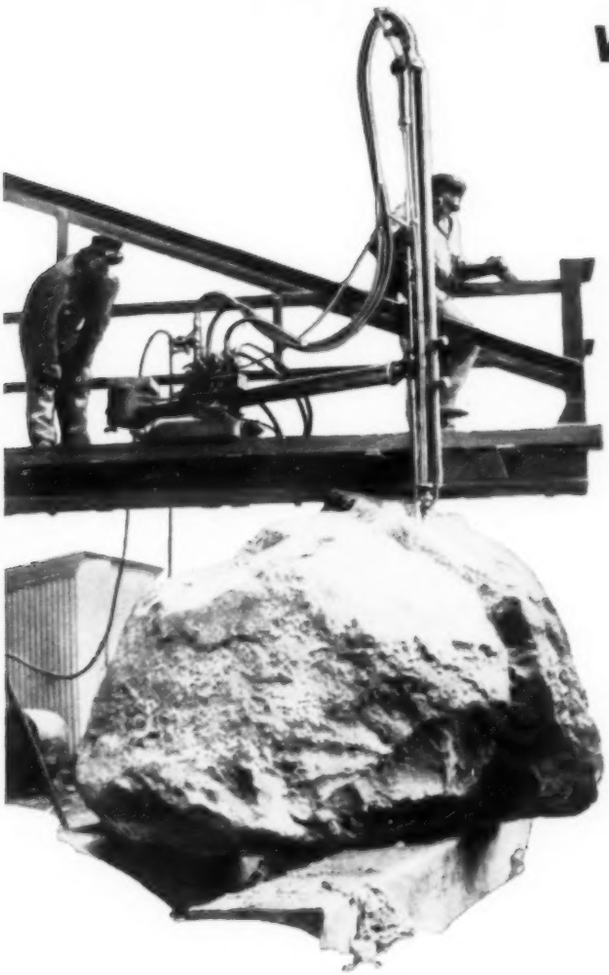

Here's the OXWELD *C-60 Cutting Blowpipe in action . . . slicing up a steel button 6 ft. thick with ease!*

Oxygen cutting rapidly converts steel sections of every size, shape, and type into good, usable scrap. Any thickness is easily reduced to charging-box size with OXWELD equipment. And no job is too tough. Whatever your scrap-cutting problem, there's an OXWELD blowpipe to solve it efficiently and economically.

For the extra-heavy jobs, the OXWELD C-60 Cutting Blowpipe with powder-cutting attachment is the answer. Especially engineered for cutting spills and ladle skulls, this combination easily makes continuous cuts through 6 ft. of dirty, slag-incrusted steel.

Other highly adaptable OXWELD blowpipes speed up medium scrapping operations. Mounted on portable, lightweight machines, they work on a production basis, cutting ingots, castings, and risers into sizes convenient for charging into the furnace.

On the lighter jobs, sturdy OXWELD hand-cutting blowpipes ready steel scrap up to 12 in. thick for the charging box. With 57 different nozzles to choose from, you get maximum efficiency at lowest overall cost.

LINDE has accumulated a vast amount of practical experience in helping to solve many unusual scrapping problems. If you have a scrap-cutting problem, ask our nearest office for help. We have the know-how, the "show-how," and everything you need to do the job profitably.

The term "Oxweld" is a registered trade-mark.

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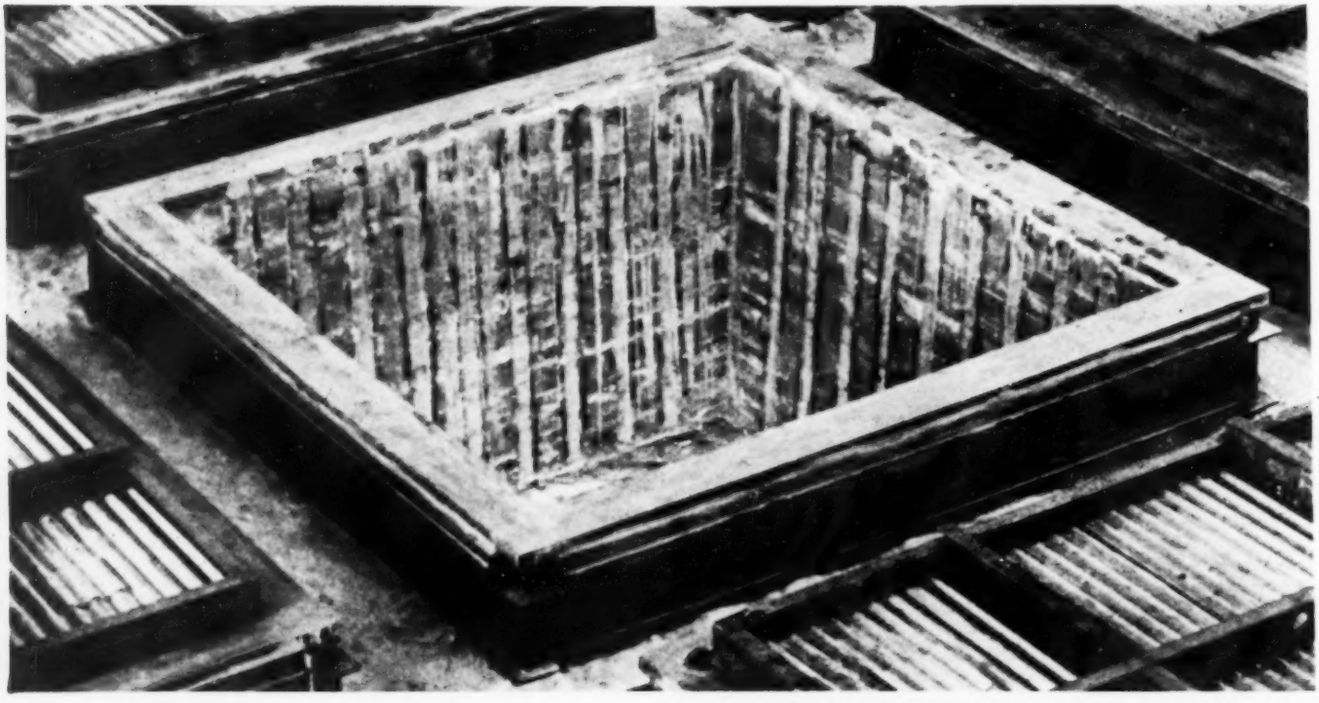
A lightweight OXWELD *portable machine speeds this scrap-cutting operation. Setup is semi-automatic and portable . . . can be easily moved from one job to another.*

Spills, salamanders, and other mill scrap can be cut quickly and efficiently with an OXWELD *hand-cutting blowpipe . . . and with minimum gas consumption.*

SUPERINTENDENT REPORTS:

"5 YEARS OF HARD USE AND NOT A CENT FOR MAINTENANCE"

on these slow-cooling pits made of Lumnite* Refractory Concrete



Nine slow-cooling pits in McKees Rocks, Pa., plant of Carnegie-Illinois Steel Corporation show how monolithic Lumnite Refractory Concrete is used to resist wear and tear at high temperatures. Pits are 14' x 14' x 6', inside dimensions. Walls taper 12" to 20" thick, top to bottom. Built by Rust Furnace Co., Pittsburgh, Pa.

Absorbing sudden thermal shocks as red-hot railroad car axles (often up to 1600°F.) are lowered into them — constantly battered as the heavy axles are charged and unloaded — these slow-cooling pits have required no maintenance in five years.

An unusual case? Not at all. It's typical of many in our files. And the reason is: concrete pits made with Lumnite calcium-aluminate cement and firebrick grog are heat-resisting and jointless. The refractory properties protect against high temperatures; the monolithic walls replace hundreds of small construction units with vulnerable edges and joints which can work loose.

Construction costs are lowered, too. Lumnite Refractory concrete can be placed by unskilled labor. No fitting or trimming of small units, no daubing with mortar. Reinforcing rail-sections are easily built in.

Lumnite is "the adaptable refractory" because, with selected aggregates, it can be cast into any size, shape or thickness. This speeds construction. And when repairs are necessary, they can be made quickly since Lumnite reaches full strength in 24 hours.

Send for further information on time- and money-saving Lumnite Cement. Write to Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N.Y.

SPECIFY CASTABLE REFRACTORIES MADE WITH LUMNITE

*"LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.

15-L-50

ATLAS LUMNITE for INDUSTRIAL CONCRETES

REFRACTORY, CORROSION-RESISTANT, INSULATING, OVERNIGHT

A UNIVERSAL ATLAS PRODUCT

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—NBC Network*

On soaking pit control systems

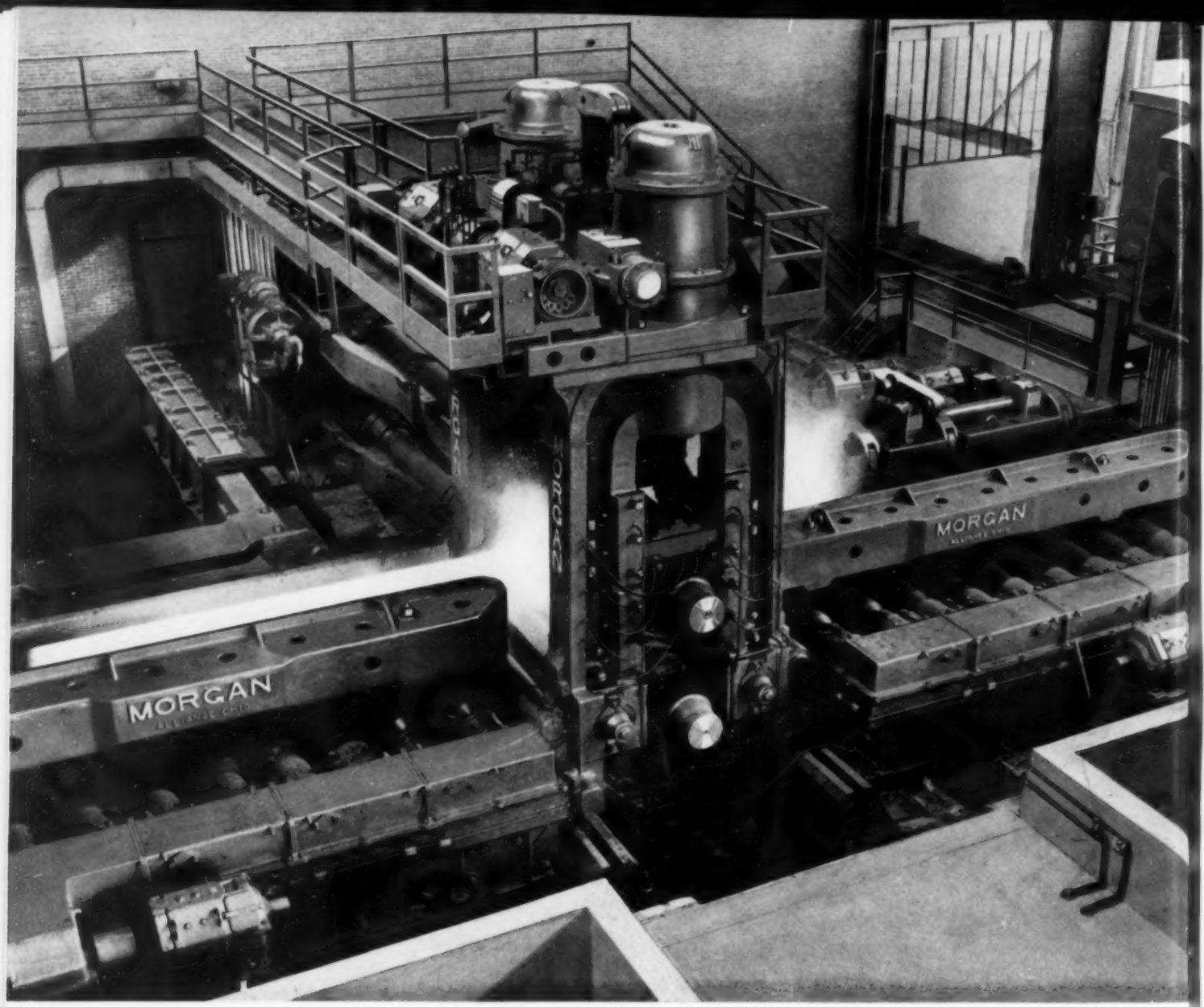
. . . this nameplate identifies the air-operated control system which has proven its dependability by satisfactory service.

Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

METALLURGICAL FURNACE CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
BOILER COMBUSTION CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES



Morgan 40″ — 2 High Reversing Blooming Mill direct connected to two 3000 Hp. 40/100 Rpm. motors. Top roll and both spindles are hydraulically balanced by individual cylinders connected to an air hydraulic system. Speeds of motor driven screw down, feed rollers, mill tables and manipulator are regulated by variable voltage control.

Mill tables have box section type cast steel girders. Rollers are forged steel equipped with anti-friction type bearing cartridges. All gears have hardened teeth, are totally enclosed and operate in oil. Manipulator is of the electric overhead type with retractable heads affording maximum accessibility to all parts of the mill tables.

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Equipment News...

TESTING UNIT SORTS MIXED STEELS BY USE OF ELECTRICAL CONTACT

▲ Non-destructive, electrical test equipment, known as the "Metalsorter," has been developed recently. Its chief application lies in sorting mixed steels or non-ferrous alloys in metals working plants and stockrooms. The test can be applied to metal materials or finished parts of almost any size or shape without the need for special fixtures or elaborate set-ups.

Almost any electrically conductive material may be sorted according to its chemical or constitutional nature. The widest field of application being in the sorting of carbon and low-alloy steels, stainless steels and the non-ferrous alloys. The relative degree of heat-treatment of finished machine parts or the structural effect of cold reduction on sheet and wire materials can also be determined in a great number of cases. It is possible to make non-destructive tests on structural or machine components even after final assembly. In this respect, the Metalsorter equipment can be used as an inspection process.

The theoretical basis for the operation of the Metalsorter lies in the tribo-electric current which is generated when metallurgically unlike alloys are caused to move in frictional contact with respect to one another. Metallurgically identical materials produce no electrical effect under similar circumstances. The "Metalsorter" employs an electro-mechanical sorting head into which a test rod of known composition is fastened. The shorting head and test rod make electrical contact with the material under test and the indication of the presence or absence of any tribo-electric current is shown by a large meter. Signal lamps on the sorting head and the control unit may also be used to show the electrical effect produced by a test, thereby making it unnecessary in most cases for the operator to view the meter in order to obtain the sense of the Metalsorter test.

The test is very rapid, generally averaging 15 to 20 determinations per minute on small parts. Several methods of testing are incorporated in the equipment to be used at the discretion of the operator.

The equipment is specifically designed for "mill" use and is isolated completely from shock and industrial vibration. A complete line of accessories, permitting almost any possible application of the Metalsorter, are furnished at no extra charge with the equipment. Dimensions are 22½ in. width, by 15¼ in. depth, by 19¼ in. height, overall. Weight is approximately 75 lb, complete; all accessories and sorting head being stored in top compartment of control unit.

Metallurgically alike materials produce no electrical effect on this unit.

SINGLE CYLINDER TURBINE MODERNIZES ORE CARRIER

▲ The latest single cylinder turbine designed especially for low powered vessels and for modernizing ore carriers on the Great Lakes is being built by General Electric for the S. S. Homer Williams. The equipment is scheduled for delivery to allow installation during the winter months so the vessel can be in regular service for the 1951 season.

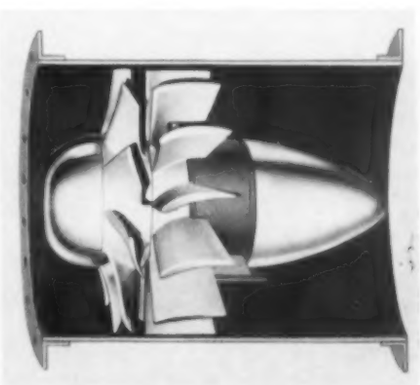
Steam conditions at the turbine will be 440 psi gage, 740 F total temperature with back pressure at the turbine exhaust flange 1½ in. Hg absolute. There will be 11 ahead stages and three astern stages mounted in a single casing, with separate inlets for ahead and astern operation. An opening is also provided for induction of steam exhausted from auxiliaries at the tenth stage of the ahead turbine, thus making use of energy which would otherwise be distributed to the condenser.

The reduction gear will be a two plane, double-reduction single helix locked train type incorporating the ship's thrust bearing in the forward lower gear casing. The normal rating of the unit is 3000 SHP at 110 propeller rpm, with a maximum rating 3300 SHP at 113.5 propeller rpm.

NEW PROPELLER FANS FOR DUCTWORK USE

▲ Propellair division of Robbins & Myers, Inc. announces the addition of two new vaneaxial type, medium pressure, propeller fans to its famous line of ventilating equipment. Designed for ductwork applications, vaneaxial fans permit series or straight-through connections for all air-moving requirements. Supplementing aerodynamically-engineered airfoil section propellers, the guide vanes prevent swirling; provide a smooth, efficient, axial flow of air. Operating on a low horsepower input, the units possess the ability to work quietly over a wide pressure range. Air loss ordinarily resulting from turbulence is converted to pressure, surface friction loss in the ductwork is reduced, and operating noise level of the fan is lowered. Steeply pitched blades, on both the propeller and vane, designed with high lift sections at the root,

The guide vanes of these new fans permit series or straight-through connections for all air-moving requirements.



utilize the latest laminar flow airfoils. Pitch and lift sections are reduced as they approach the tip to provide uniform discharge velocity over the entire blade area. Positioned directly behind the propeller, the vane is mounted independent of the heavy gauge welded steel drum. Spun aluminum nose and tail cone, providing the functions of streamlining the air flow, are contained within the distance between the two mounting flanges of a 30 in. duct section. Easily installed in standard 20 in. and 24 in. diameter duct systems, the units are equipped with open-ventilated, ball bearing, 40 C rise, standard NEMA foot-mounted motors built by Robbins & Myers, Inc. Adaptable to almost any type of ventilating requirement, Propellair Vaneaxial Fans are available in two models for characteristic temperature and atmospheric conditions. Type VCDD direct driven units, constructed with the motor inside the airstream, are suitable for non-hazardous applications, while Type VCS belt-driven units are recommended for installations in which corrosive or inflammable fumes, dusts, or vapors must be considered.

HOIST WEIGHING 39 LB HELPS LABOR SHORTAGE

▲ Weighing only one-half as much as conventional hoists of the same capacity, a new Yale hand chain hoist made by the Philadelphia division, Yale & Towne Manufacturing Co., enables one man to lift 1000 lb with less work than it takes to climb an average flight of stairs. For example, the new Yale ½-ton capacity model (weight 37 lb) has near-impossible 95 per cent efficiency permitting a full load to be easily raised three feet in 20 seconds.

Called the "Load King," the new hoist will help plants that are feeling the pinch of manpower shortages and the squeeze of high handling costs. It has "carry around" lightness, even in the models designed to lift two tons, and can be moved to the job in a hurry.

Workers, too, will like the "Load King." One man can always operate all models with ease, and its muscle-saving features will leave operators feeling better at the end of a working day even though they've accomplished more work.

This new hoist, weighing half as much as conventional hoists, has 95 per cent efficiency.

Behind the performance figures of the new Yale hoist lay its design innovations. The use of high strength aluminum castings and alloy steel plus fewer parts make it a feather-

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Mark ladle-test pieces with furnace number, year-code letter and heat numbers—in 50% less time with this type holder. Complete mark is made with one blow. Marks are in straight line, of even depth, easy to read—reduces errors in stamping and identifying tests. Eliminates danger of hitting fingers with hammer. *Write for proposal on your needs.*

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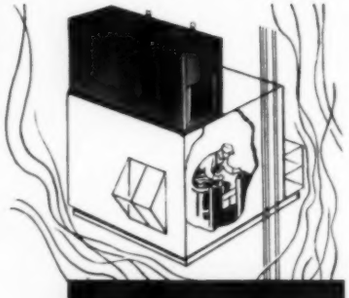

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REPEAT ORDERS from steel, iron and non-ferrous metal producers offer proof of the outstanding results where Dravo Crane Cab Coolers reduce fatigue and improve operator performance. It's worth your while to call or wire Dravo for case history details of these applications.

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DRAVO

Integrator

Indicator-Recorder-Integrator

Varying flows are accurately totalized because the integrator is continuous

The Republic flow integrator, being of the modified watt-hour type, totalizes continuously—not intermittently. It operates independently of the recorder and its accuracy is not dependent on or affected by any clock mechanism or mechanical action.

The Republic meter is, on this account, peculiarly fitted to follow all changes in flow rate and accurately measure highly fluctuating flows.

ALL TYPES OF FLUIDS

Republic electric type flow meters are available for measuring the flow of all types of liquids and gases. Meter bodies are built for metering fluids at line pressures up to 5,000 lb. per sq. in. and for all ranges of differential pressure. The reading instruments—indicator, recorder and integrator—are of the remote reading type and can be located any distance from the point of flow measurement.

ANY COMBINATION

While each Republic reading instrument is standard in design and construction each is especially calibrated for the particular flow measurement for which it is specified. Any reading instrument, indicator, recorder or integrator, may be obtained separately or in any combination desired, making possible the highest degree of flexibility in plant use.

SIMPLE IN OPERATION

The Republic electric meter is the only flow meter commercially manufactured which is strictly electric in its operation. All other types of so called electric meters use the motion of the mercury to move a float or produce a force which is then converted into an electrical value which is in turn transmitted to a receiving or reading instrument. In the Republic meter, the transmitted electrical value is determined directly by the mercury motion, thus eliminating one of the steps in the sequence, and simplifying the mechanism to that extent. There are no floats, levers, cams, rotating shafts or anything else to interfere with the unimpeded movement of the mercury, which has no work to perform, but merely fulfills the function of making contact.

NEW DATA BOOK

Just off the press—a completely new data book describing and illustrating, in detail, the operating features of the Republic Flow Meter and its many applications. Write for your copy of Data Book No. 702—there is no obligation.

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weight without sacrifice of strength or headroom. High speed operation of the "Load King" at unusual efficiencies is due to minimized friction: all rotary shafts have ball bearings, and parts are precision machined.

A new load brake "Synchromatic" provides split-second automatic braking when hoisting or lowering. Balanced and cushioned springs force engagement of a six tooth pawl and a 24-tooth ratchet assuring positive, immediate braking action without any harmful side pressure on bearings. A stabilizer ring speeds brake release for precise inching when lowering a load. This permits the load to be gently eased to the floor or accurately spotted at any vertical distance above it.

Other features of the new Yale hoist include a one-piece housing for support of shafts and bearings — assuring perfect alinement for all times — and a new chain of heat-treated alloy steel operating over sheaves of the same material, assuring long usage and minimum wear.

The "Load King" is available in ½, 1, 1½, and 2-ton capacities, with chain provided for a standard lift of eight feet.

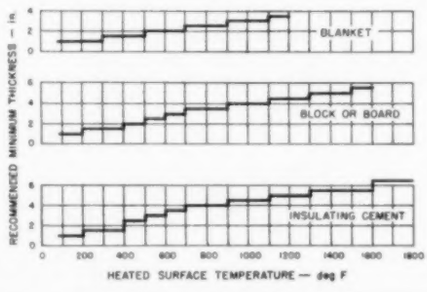
INDUSTRIAL INSULATION CHART SAVES HEAT

▲ Industrial insulation pays for itself many times over in heat savings when applied to the proper thickness. Where it's too thin for the job you do not get the results you are paying for. Where it is too thick, you are buying more labor and materials than you need.

The type of insulating material, as well as the heated surface temperature, determines the proper insulation thickness. At temperatures from 70 F to 1800 F the chart gives the recommended minimum thicknesses of mineral wool in its blanket, block (or board) and insulating cement forms.

Commercial Standard CS117-49, "Mineral Wool Insulation For Heated Industrial Equipment," recommends these thicknesses for indoor locations. Outdoors, add half an inch; underground, subtract half an inch.

The chart gives recommended minimum thicknesses of mineral wool.


RECOMMENDED MINIMUM THICKNESS — IN.
BLANKET
BLOCK OR BOARD
INSULATING CEMENT
0 200 400 600 800 1000 1200 1400 1600 1800
HEATED SURFACE TEMPERATURE — deg F

MARKING DEVICE FOR ROUND OR CURVED PARTS

▲ A new marking device for stamping round or curved metal parts is the latest development of M. E. Cunningham Co. Identified as the PF-20 periphery stamping fixture, this new marking tool features a unique type arrangement which permits the use of regular straight body type for curved marking.

The improved retaining feature, which allows the characters to stamp on a specified curved radius, eliminates the need for retaining pins and slotted type. The holder can be made suitable for one or two rows of type, which is easily changed by removing

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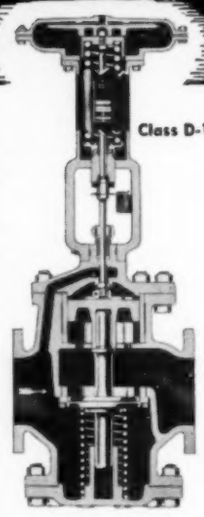

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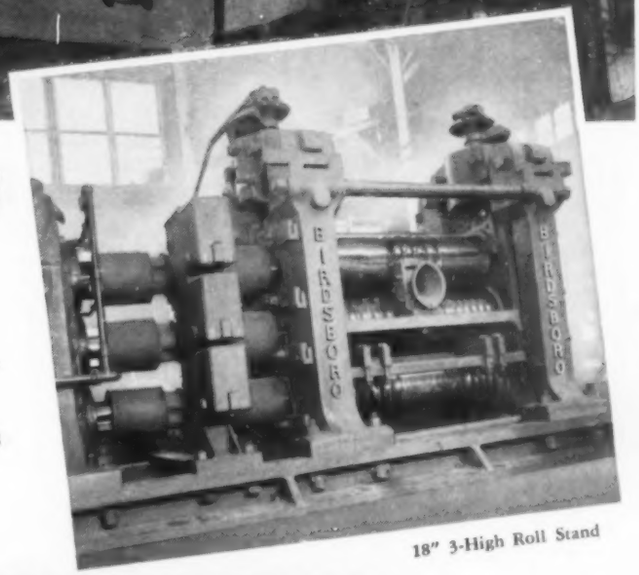

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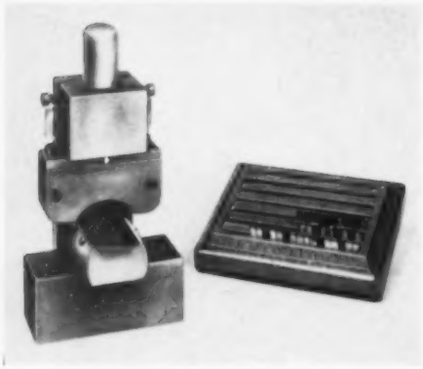


Retaining pins are not needed with this new stamp.

the face plate of the holder. The number of characters that can be used are limited by size of characters and radius of the piece to be marked.

Periphery stamping fixtures usually are made to order for marking a specific part, but they also can be manufactured adjustable for use on various shapes and sizes. However, when the degree of curvature changes, a different type holder must be used.

Construction includes springs which lift the holder off the piece after it has been stamped. Gages and arbors can be made to suit any part to be marked.

PRODUCTION STARTS ON GAS TURBINES

▲ Large-scale production of gas turbines, latest type of power plants for land, railroad, and marine use, has been started by the General Electric Co.

Glenn B. Warren, manager of the company's turbine divisions, announced that "accelerated production" has begun on the first few of more than 20 gas turbines scheduled to be built within the next two years for power generation and for gas pipeline pumping stations.

"Technological advances during the last 12 years and the successful operation of units now installed indicate the gas turbine is ready to assume a significant role in the power field, along with steam and mercury power plants," Warren said.

"Further advances," he said, "will find the gas turbine an effective tool, when properly applied, for still further reducing the cost of power."

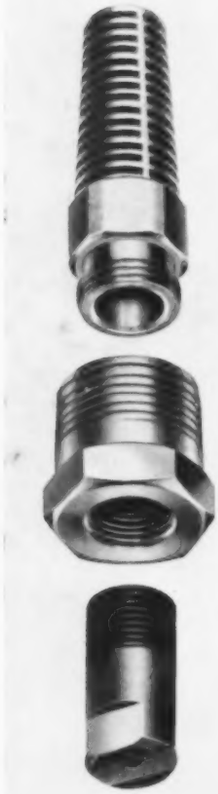
Units are now being built in a factory building containing 250,000 sq ft of floor space. He pointed out that the building, in which modern manufacturing and test equipment is now being installed, will be in full-scale production within eight months.

Gas turbines now scheduled for production, he said, will be in three basic models:

A 3500-kw (4800-hp) simple-cycle type, similar to three units now operating—one for a Southwestern utility company, one for a New England power company, and the other in a gas turbine-electric locomotive;

A 5000-kw two-shaft compound-cycle type for power generation use;

And a newly designed 5000-hp two-shaft mechanical-drive type for gas pipeline pumping and other applications. This, according to Mr. Warren, will be a more efficient machine than the 3500-kw simple-cycle machine. A unit of this type with a 4000-kw generator has been sold to an electric utility for power generation.



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Spraying Systems
Descaling Nozzle

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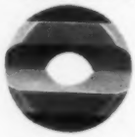
LARGE DIAMETER ORIFICE



Note that the orifice is almost circular in shape . . . far less tendency to clog than the "old style" slotted orifice. Initial cost is lower. Maintenance cost is lower.

Write for complete information on this quality built nozzle and its large capacity strainer and adapter. Ask for Catalog 22 and Data Sheet 3997.

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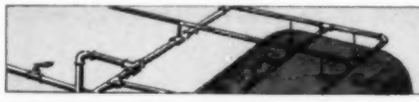
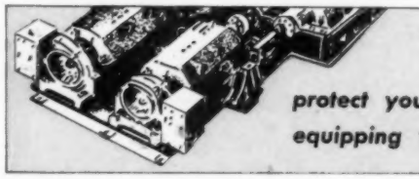


Are You Exposing Costly Machines To Serious Damage?



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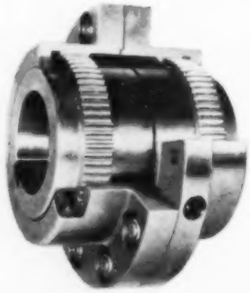

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ANNOUNCE REDESIGN OF INDUCTION MOTORS

▲ Allis-Chalmers has announced the redesign of its standard line of large, bracket-bearing, squirrel-cage induction motors of four and more poles to provide more protection and greater accessibility.

Capsule-type sleeve bearings are standard. The split, cast-iron bearing capsule or housing has a machined flange for bolting to the bearing bracket. This permits removal of the upper half of the bracket for inspection or cleaning without exposing the inside of the bearing. Similarly, the ample air-discharge openings in the side of the stator yoke, protected by removable louvers, facilitate vacuum cleaning or blowing out the air passages behind the stator core.

Since the only openings in the bearing brackets are in the air intakes near the bottom, the brackets afford effective protection for the ends of the motor. This construction, plus the use of louvered panels in the stator air-discharge openings, makes the standard design drip-proof. Splash-proof motors with internal baffling of air passages are also available.

The large, stator air-discharge openings also facilitate installation by providing adequate headroom for drilling and dowling the machine to its foundation. In addition, the foundation bolts and dowling are out of sight behind the discharge louvers. Tapped, plug-protected holes in the brackets permit easy checking of the air gap.

Ventilating air intake and discharge openings and internal passages in both the bearing brackets and the stator are liberally proportioned to provide uniform ventilation for freedom from hot spots and moderate air velocities for quiet operation.

The motors are available with special electrical modifications to suit application requirements. They can be had with anti-friction bearings whenever the speed and application are suitable.

Bracket-bearing, squirrel-cage induction motor construction in this Allis-Chalmers line is standard for ratings up to 1 hp per rpm. However, for steady, non-overloading industrial drives (such as centrifugal pumps, blowers and fans) bracket-bearing construction may be used for ratings up to approximately 1.5 hp per rpm for motors in the high speed class up to 900 rpm.

LUBRICATING GUNS ARE ELECTRICALLY POWERED

▲ Two new design high pressure electric powerguns, of 25 lb and 40 lb capacity, for use where air power is not available, have been announced by the Alemite division of Stewart-Warner Corp.

The 25-lb gun, Model 7170-R, will deliver 14 oz of light or medium lubricant per minute at 70 F. It will handle all greases that seek their own level and develops 5000 lb pressure. Has 115-volt 60-cycle universal motor with heavy duty switch which automatically shuts off motor when 5000 lb pressure is built up. Complete with seven feet of ¼ in. inside diameter high pressure hose, ball bearing Z-type swivel and control valve. Rear wheels are 8 in. in diameter, front wheel 4 in. available in rubber or steel.

The 40-lb gun, Model 7175-R, handles all types of grease, fibrous, heavy or light. It has helix arm and worm gear priming, and delivers 5½ oz of heavy fibrous lubricant per minute at 70 F. Develops 5000 lb pressure and has heavy duty 115-volt 60-cycle universal motor with switch which automatically shuts off motor when maximum pressure is built up. Complete with 10 feet of ⅜ in. inside diameter high pressure hose, bail bearing Z-type swivel and control valve. Available with 8 in. rear and 4 in. front wheels, of steel or rubber, or with 8 in. front and 16 in. rear wheels of steel. Where stationary or truck mounting is desirable, Model 7175-R is available less wheel assembly and hose assembly.

PNEUMATIC TIRES USED ON HUGE TRUCK

▲ Of unusually high capacity is a fork lift truck on pneumatic tires just introduced by the Ross Carrier Co. Designated Ross Series 24, this giant for truck handles loads weighing 24,000 lb and 92 in. in width. Series 24 meets the need for a fork truck capable of further reducing handling costs by handling materials in big unit loads. Big 14.00-20 pneumatic tires plus plenty of weight on the driving wheels enables the Ross Series 24 to operate efficiently in yards having a minimum of prepared surfacing. The Series 24 is powered by a heavy duty 126 hp gasoline engine and features a heavy duty spiral bevel differential drive axle with chain drive to a stationary load axle. Hoisting, tilting and steering are hydraulic.

This new fork truck, using pneumatic tires, has unusually high capacity.

125,000 KW GENERATOR FOR EASTERN UTILITY

▲ The Westinghouse Electric Corp. received a contract for a 125,000-kw generator to be installed in the Delaware station of the Philadelphia Electric Co. This will be the largest of its particular type ever built by the company and the largest yet to be installed in this country.

A new insulation called Thermalastic recently developed by Westinghouse will be used in the generator. This insulation consists of mica flakes embedded in tough, heat-resistant, synthetic resin with sufficient stretch at operating temperatures to expand and contract with the generator coils. Tests indicate that this new insulation has a life at least ten times as great as previous insulations.

The "two-pole" machine will operate at 3600 revolutions per minute. Hydrogen gas will serve as a coolant for the generator with the housing being designed and tested to withstand 30 pounds per square inch internal pressure; the normal operating pressure will be only ½ pound per square inch.

The steam turbine which will drive the huge generator, will be built at the South Philadelphia steam division of the company.

THE ENGINEERING MART

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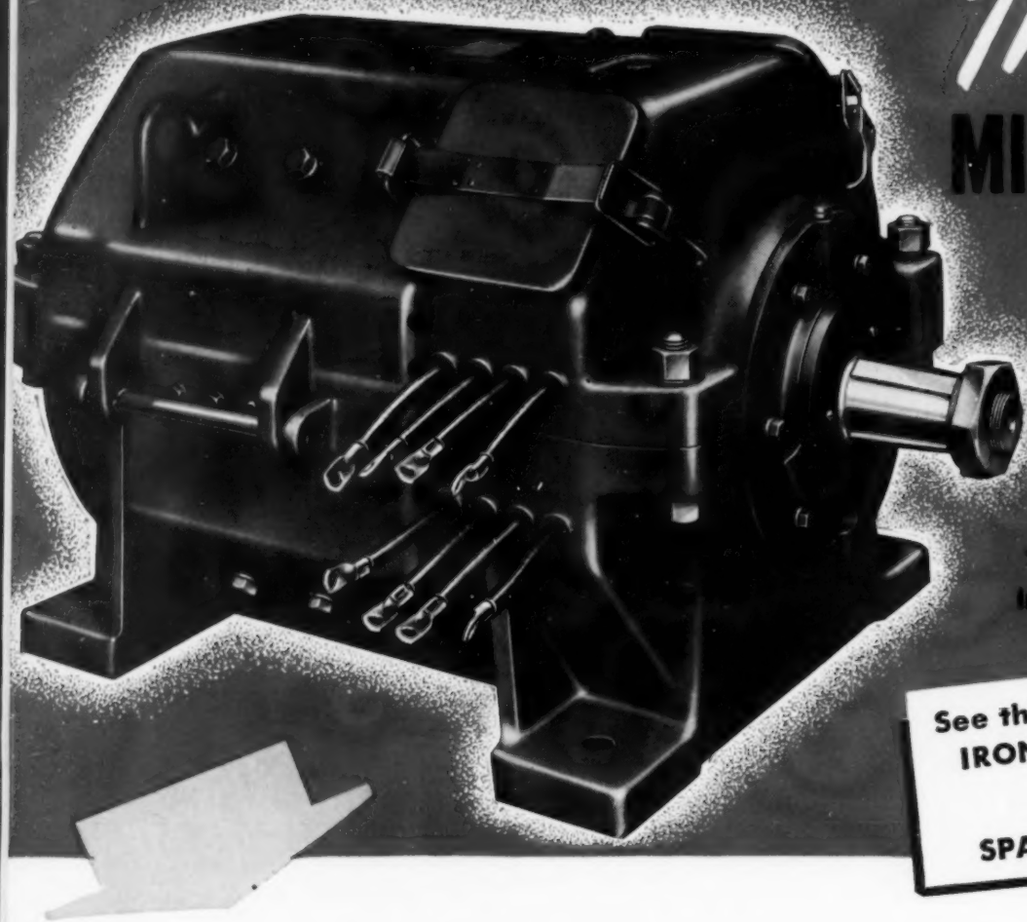
CROCKER-WHEELER



The First MILL MOTORS

now available in the new
W600 Series

Still First

in every test for
trouble-free performance
in the toughest mill service

See them demonstrated at the IRON & STEEL EXPOSITION
ELLIOTT
SPACE NOS. • 295-298

Crocker-Wheeler built the first Mill Motor over 45 years ago. Now, from this unequalled experience comes the new W600, a compact package of dependable power that is more than a match for the heavy overloads, and severe reversing strains of today's most punishing mill service.

W600 conforms in all respects to the new AISE standards. Offering more power without increase in frame size, it's a natural for all replacements. For new drives, you'll find it a revelation in trouble-free performance and simplified, low cost maintenance.

See C-W Mill Motors put through their paces at the Cleveland Exposition. You'll see why the first Mill Motors are still first with production-wise mill men. New Bulletin SL-620-1A sent free on request. Write: Advertising Department, Elliott Company, Jeannette, Pa.

For heavier services— modernize with

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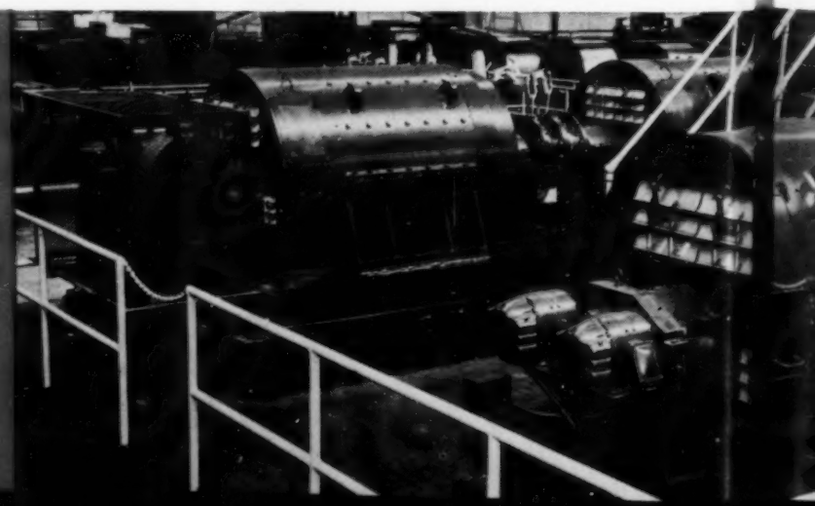
FABRI-STEEL
MOTORS AND GENERATORS

available from Ridgway Division of Elliott Company, Ridgway, Pa.



Engineered throughout for top efficiency

MORE POWER WITHOUT INCREASE IN FRAME SIZE Elliott Crocker-Wheeler W600 Motors meet AISE requirements for higher output from existing frames. For example the new C-W 7½-hp Mill Motor fits into the former 5-hp frame.

MORE EFFECTIVE COOLING Improved, directed internal air circulation increases heat transfer to frame for greater loss dissipation per unit area. Motors stay within established temperature limits despite increased power per frame.

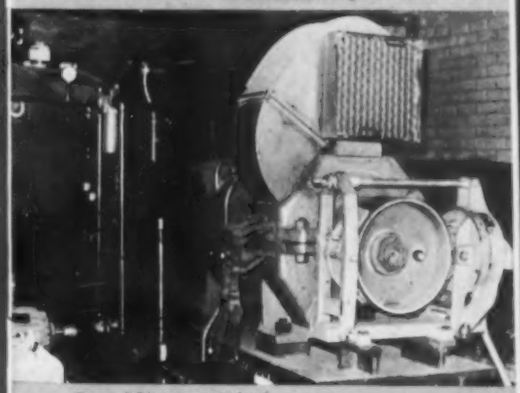
IMPROVED INSULATION Armature coil insulation utilizes silicone bonded, double-glass-covered wire and glass-backed mica tape. Similar use of new insulating materials in field coils assures lasting resistance to high temperatures, moistures, and oil.

BETTER COMMUTATING CAPACITY Improved design assures proper commutation under punishing service, such as overloads with rapid plugging, reversing, and high speed. Tests up to 300 per cent current show negligible sparking.

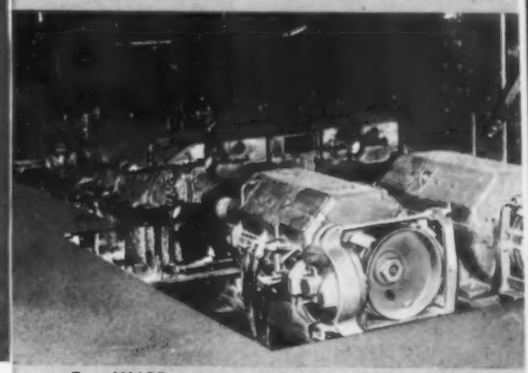
GREATER SHAFT STRENGTH Despite the increased rating, requiring motors to transmit about 50 per cent more torque, maximum shaft stresses are not increased over previous AISE standardized Mill Motors.

TIME-SAVING ACCESSIBILITY Rugged cast steel split frame is hinged (except in 3 largest sizes), permits ready access to all motor parts. Fan diameter does not exceed armature core diameter. This, together with lifting eyes and supporting feet on armature bearing cartridges, facilitates handling and avoids possible damage to fan and armature.

At Rotary Electric Steel Company ELLIOTT CROCKER-WHEELER W600 Mill Motors meet modern efficiency standards



Two 250-hp, 420/480-rpm separately excited, forced-ventilated, shunt wound W600 motors drive the up-cut shear.



Two W600 motors in tandem on the manipulator. Four similar motors are on front and back work tables.

Crocker-Wheeler W600 motors have been already performance-proved for high efficiency and low maintenance in many installations. The motors shown above have been in service over a year at the Rotary Electric Steel Company, Mound Road Plant, Detroit.

Elliott C-W 75-hp Mill Motors operate the auxiliaries of a 36-in. blooming mill, and are also used on the cranes in sizes up to 75 hp. In addition, other C-W motors up to 35 hp are used for such drives as the mill delivery table, shear approach, and ingot pusher.

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Ampere, N. J.

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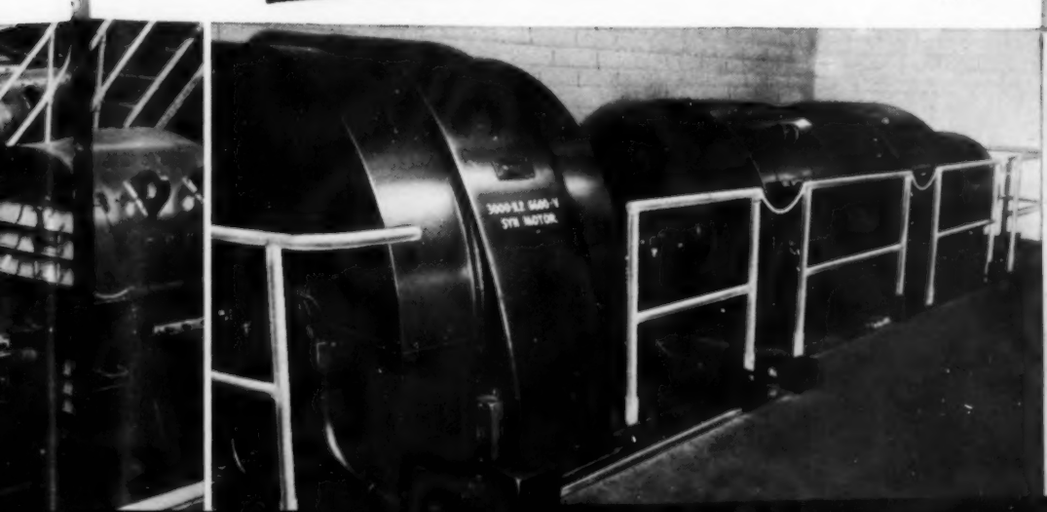
CW-9



At Carnegie-Illinois, Elliott powered drives boost speeds from 500 fpm to 2500 fpm, provide for further increase to 3750 fpm.

One of two Elliott 600-hp, 450/1000-rpm enclosed forced-ventilated main roll drive motors (left, opposite page). In background are two tandem-coupled Elliott 500-hp, 250/965-rpm recoiler motors.

Four-unit Elliott 2100-kw motor-generator set (left) provides the adjustable voltage power through three generators for two drag generators, two main roll drive motors, and two recoiler motors.

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NEW SIMPLIFIED "50" SERIES

SHEFFIELD MEASURAYS

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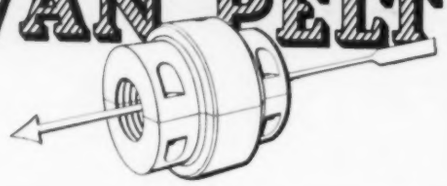
VAN PELT



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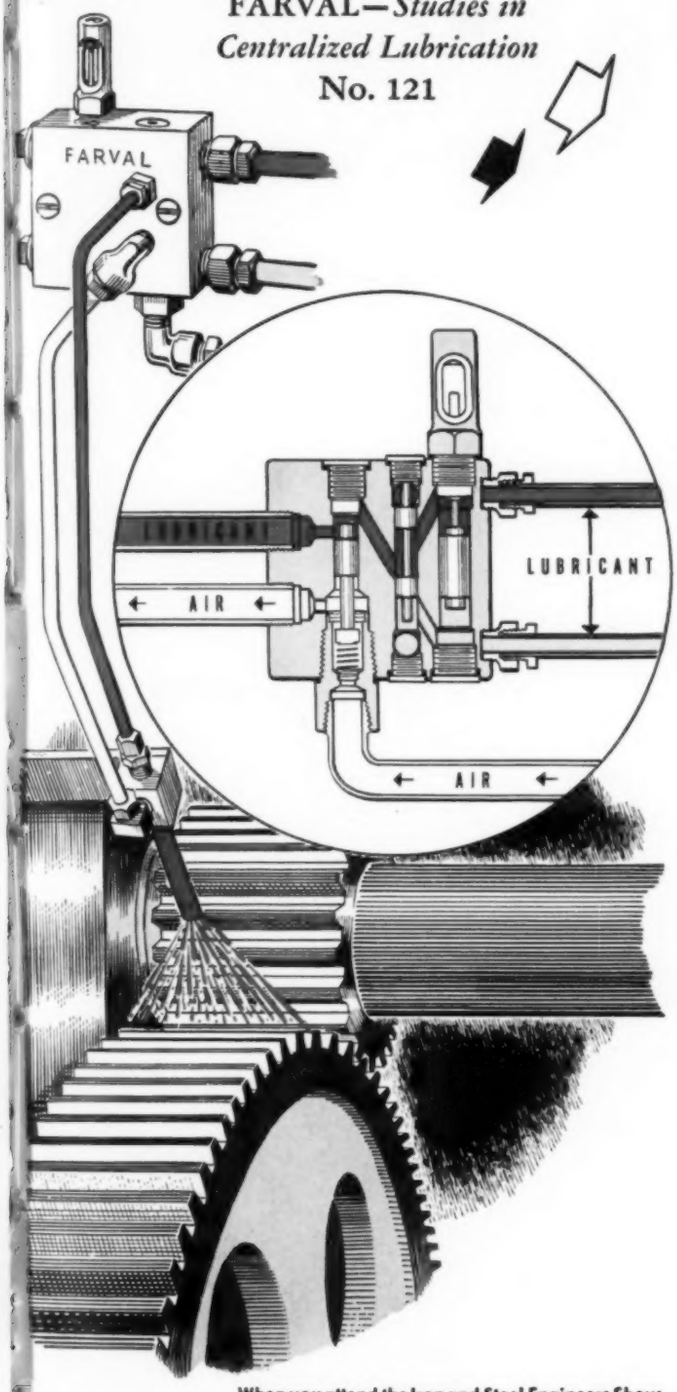
FARVAL—*Studies in Centralized Lubrication* No. 121

New Farval Spray Valve

meters lubricants to slide surfaces and open gearing



CONTROLLED spraying of lubricant on open gearing, slide surfaces, etc., is practical with the new Farval Spray Valve.

By an ingenious adaptation of the familiar Farval Dualine Valve, either grease or oil is sprayed through a nozzle—on any desired area, in any desired amount, and at any desired interval. The new spray valve can be added at any point in a regular Farval Dualine System where compressed air is available—or a complete system may consist entirely of spray valves, served by either manual or automatic pumping unit.

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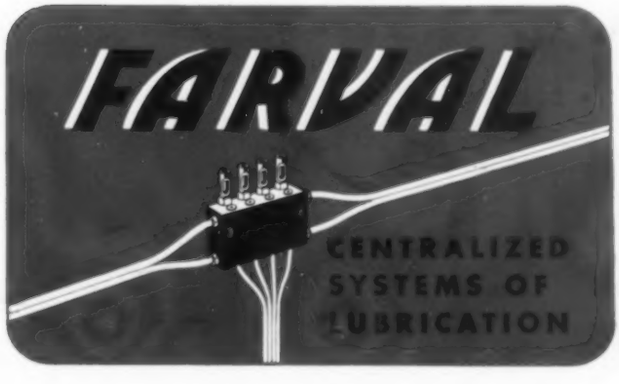
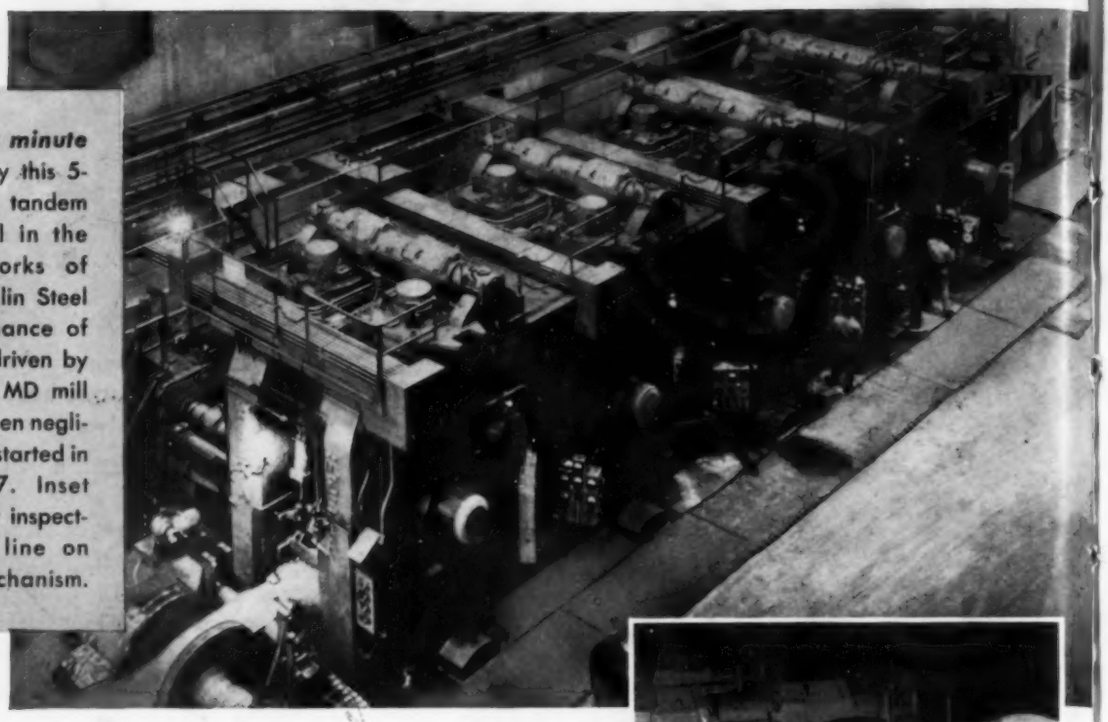
The Farval Spray Valve has been thoroughly tested in service and is now in use on a wide variety of machines and equipment. It has demonstrated its ability to supply lubricant efficiently and economically to open gearing, slide surfaces, in fact, wherever a standard Farval Dualine closed system is not readily adaptable.

Write for a copy of Farval Spray Valve Bulletin No. 60 for a full description, with illustrative diagrams and installation data. The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

When you attend the Iron and Steel Engineers Show at Cleveland Public Auditorium, Sept. 26-29, be sure to stop at Farval Booths 244-245-246 to see this new Spray Valve in operation.





6250 feet per minute is record set by this 5-stand 42-inch tandem cold strip mill in the Aliquippa Works of Jones & Laughlin Steel Corp. Maintenance of screwdowns—driven by 10 G-E 75-hp MD mill motors—has been negligible since mill started in October 1947. Inset shows operator inspecting oil feed line on screwdown mechanism.

Cuts maintenance costs

ON WORLD'S FASTEST STRIP MILL!

G-E d-c mill motor for extra-heavy duty provides extra convenience features like these:

- Wide commutator opening gives easy access to entire brush holder without opening frame
- Hinged top, on most frame sizes, swings open full 180 degrees, simplifies inspection
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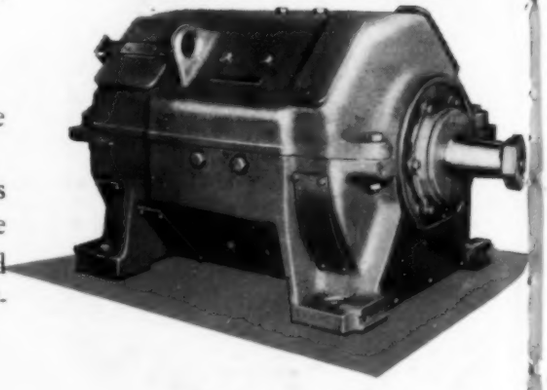
- Pressure-relief greasing system with easy-to-get-at fittings facilitates lubrication

And much more besides:

- Sturdy, compact construction that provides more hp in the same AISE frame size
- Base is easily converted with standard covers to provide five types of enclosures, saving cost of extra standby motors and storage space
- Plus many other features that add up to long motor life and dependability. Write for Bulletin GEA-4654. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

MD-600 MILL MOTORS



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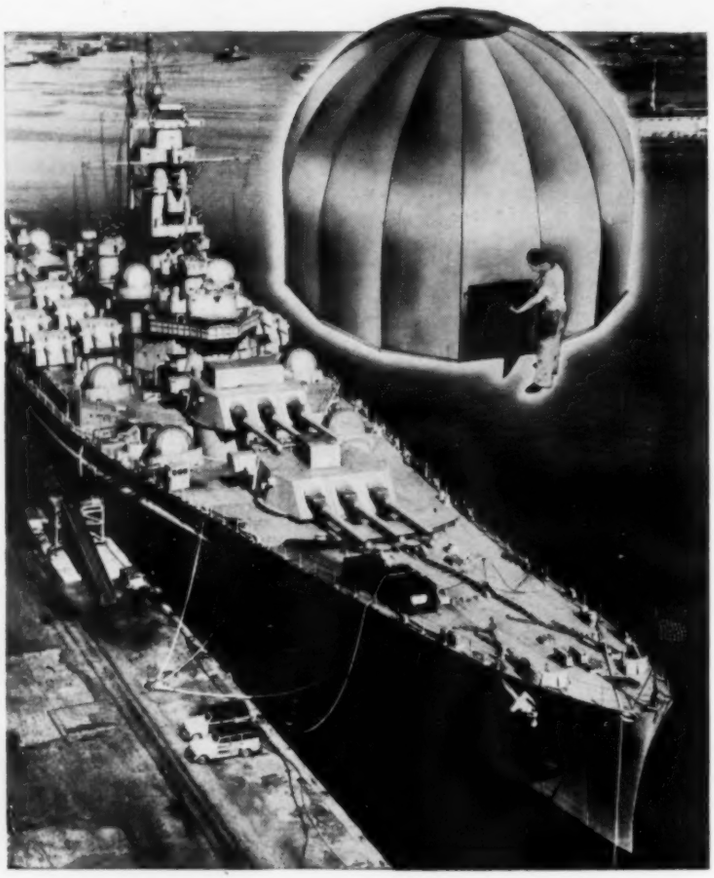

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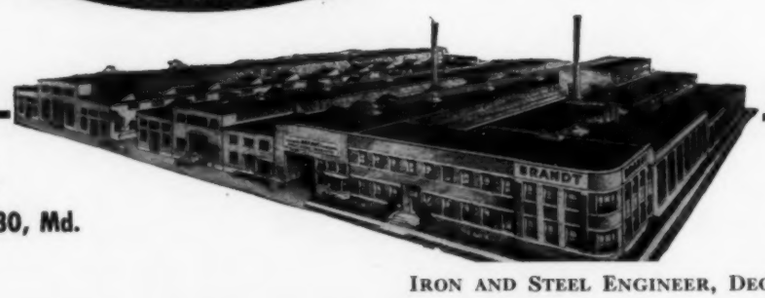
- WELDMENTS
- PRESSED STEEL SHAPES



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